The Modern Treatment of Binocular Imbalances

R. M. Peckham, Opt. D.

Sincerely

Ruth Eckhardt

THE MODERN TREATMENT OF BINOCULAR IMBALANCES

with the

GENOTHALMIC KRATOMETER

2ND EDITION

Rewritten and Enlarged 1928

By

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With a Foreword

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THE
MODERN TREATMENT
OF
BINOCULAR IMBALANCES

To those refractionists who, sensing the increasing duties imposed on them in this day of exacting visual demand, are seeking ways of alleviating distress, this volume is dedicated by author and publishers.

FOREWORD

From glacial period to organic life; from ape to man; from Bourbon to Republic; from life to death; from night to day—all seem the result of sudden change. Yet the causes underlying the earth's changes go back millions of years, those of man's evolution thousands of years, those of the French Revolution hundreds of years, those of death scores of years, and though day "breaks" the underlying causes circle back millions of years.

Because of this the belief is naturally fostered that all changes take place abruptly when in truth that which we call the change and try to squeeze into a definitely circumscribed period is the end-result or immediate recognition of the consummation of changes that have been brewing over long periods—we recognize the boiling point, giving undue prominence to the bubbling, while forgetting the cumulative action of the underlying heat.

Thus the changes we all recognize in our attitude toward binocular inbalances due to Peckham's brilliant exposition of the true underlying principles seem sudden and cause misgivings. But I incline toward the belief that the same laws of change have governed these as governed those mentioned above.

To believe this gives me comfort inasmuch as I have the same fear of sudden, revolutionary changes as has any conscientious practitioner. Yet while I am more than anxious to be conservative I draw a very sharp distinction between the conservative and the reactionary. Conservatism and old fogeyism, as Osler so aptly points out, are totally different things; the motto of one is "Prove all things, and hold fast that which is good," and of the other, "Prove nothing, but hold fast that which is old."

This Kratometric work outlined by Peckham, if we so will, may grow as a virgin forest wherein sound ideas may reach towering heights unencumbered by any rank undergrowth of reactionary old fogeyism.

But we must so will. I see many signs of holding fast that which is old because it is old and refusing to test or prove the new for no better reason than that it seems new.

Such a spirit not only retards the general advancement but will prove fatal to the individual. Let us then as individuals not only refrain from retarding the general advancement but profit individually by the work so unselfishly carried out by pioneers such as Peckham. Let us be conservative but let us shun old fogeyism for selfish, if for no higher, considerations.

One change in my viewpoint toward the treatment of binocular imbalances can be traced back many years through a smoldering distrust of the vicious dictum which advocated the correction of the refractive error and the complete disregard of the extrinsic muscular imbalance. Had Peckham done nothing more than expose the fallacy of monocular refractive correction, however precise, and the transcendental importance of binocular balance he would be entitled to unlimited gratitude.

Hence I do not consider that I am giving up something tried and true for something that may be no better nor as good but, rather, that I am following a simple line of duty in seeking something to take the place of that which has proved untrustworthy. The old methods carried me along the wrong road and while I do not know how far he may carry us or how far I may be capable of following him, I do feel that Peckham has set us upon the right road. And it is pertinent here, I think, to remark that having been set upon the right road, some effort to advance is due from us without crying for a permanent seat upon his shoulders.

For more than thirty years I steeped myself in and became saturated with the muscular imbalance philosophy of Worth, Maddox, Valk, Savage, Landolt, Eberhardt, Kletzky, Howe, Stevens, Banney, Gould and a host of others with whom you,

too, are just as familiar—great philosophers all but not a real physiologist or neurologist in the lot.

How can I forget then, so long as I live, the sensation I experienced on reading Peckham's original Boston address and awakening with startling vividness to the realization that all the old fallacies had been toppled over by one clear-cut conception of the fundamental cause of binocular imbalance? Oh, the subtle but essential difference between muscular anomalies and binocular imbalances that Peckham was the first to point out clearly! Until the full significance of that difference is grasped no headway can be made, after it is grasped little more need be said.

The misleading expressions of strong or weak muscles, long or short muscles, properly or faultily attached muscles, the fogs of half-knowledge, are dissipated at once by Peckham's fundamental conception that the imbalances we are called upon to treat are functional, not structural—physiological, not anatomical.

Such a masterly stroke was bound to produce many marked effects. It produced a revolution in my practice, nothing radical, but a change not so much in the way of equipment, of technique, or of treatment as in the manner of handling my cases and the peace of mind that goes with the conviction that one is headed in the right direction.

With the exception of adding a Kratometer I utilized every piece of equipment I already possessed; I simplified my routine examination, obtaining a more intelligible analysis in less time and with less confusion; and I treated many cases with some semblance of understanding that previously I had treated blindly on a hit-or-miss basis.

When Peckham's early work let the first ray of hope fall through a rift in the appalling darkness of my chaotic muscle work I was no mere beginner attracted by the first bright object that presented itself but a hardened skeptic who, like

you, had found prisms 'poison' so often that I had acquired the habit of blaming the prisms and ignoring the faulty methods of employing them. But the principles he presented were so transparently simple that it seemed not a question of adopting something new but a mere brushing of the dust off the old gold we knew to be there all the while.

Peckham did not build or fill nor ever claim to have built or filled the treasure house but it was given to him to present us with the charm—the open sesame—which unlocked the door to the means by which, if by any, we may fulfill our destiny and solve the binocular imbalance problems which had remained unsolved and which had left in their train nothing but suffering and discouragement. These means, I repeat, are the principles of physiology in place of anatomy—the principles of function in place of structure.

Optometry and Ophthalmology alike have done all too little original work, let us, therefore, evaluate fairly and stand squarely behind this of Peckham.

While I shall be everlastingly grateful to him for the new light he has thrown upon these specific problems in binocular balance, I shall ever be still more grateful for the big general field his ideas have opened to me. I do not know how far back the causes ran, I do not know how close I may have been to a change, but I do know that his work inspired and precipitated a change in my conception of Optometry that has made my job twice as big, twice as important, twice as useful and twice as remunerative.

And because of a sincere belief that his work holds the same promise for all my professional colleagues as it held for me I find a double pleasure in wishing Godspeed to this little book as it starts on what I venture to predict will prove a momentous voyage.

E. LeRoy Ryer

Nine East Forty-Sixth Street
New York City

Foreword
to the First Edition

It was merely a question of the ostrich hiding its head in the sand when the pernicious advice was formerly given to correct the refractive error and let the extrinsic muscles "take care of themselves"; or the hazardous cutting and linking of the ocular muscles was advocated in the hope of making a balanced condition. Though the real issue was ignored, it never ceased to exist, for in every pair of binocularly functioning eyes there is a perfect or imperfect, normal or abnormal, comfortable or uncomfortable working arrangement between the intrinsic and extrinsic ocular muscles. Upon whether this synergistic relationship be a happy or an unhappy one depends the ocular comfort of the patient—and perhaps the ultimate welfare of the refractionist.

Unfortunately most of the work done toward solving muscular imbalance problems was directed along improper lines. The tests devised under this guidance tended to show faulty attachments, faulty verting powers, faulty tendencies, in brief, faulty structural conditions which, if they do exist, have little to do with Binocular Balance.

Now, thanks to Hazen's invention of the Kratometer and to Peckham's keen recognition of its broad possibilities and his development of a simple technique, we know that, with a very few exceptions, muscular imbalances are due to faulty innervational habits, or misdirected innervation.

Thus, the entire aspect of ocular muscle work has changed. Knowing the governing principle, it is now a relatively simple matter to uncover and remove the cause of muscular imbalances and to achieve comfortable Binocular Balance.

The instrument, and the only instrument, that enables us to do this work is the Genothalmic Kratometer.

Whether you believe in prisms in the position of rest, or in innervational development, or in a wise admixture of these

two systems, you will come to the Kratometer for the most comprehensive diagnosis and the most simple and effective means of applying developmental measures.

We have deemed it wise to give detailed instructions, however elementary they may seem, for making each test and for applying each corrective measure.

A superficial glance may cause such instructions to appear complicated; but attentive perusal will show that they are not only simple but outline definite methods of procedure that make it easy to use this instrument, even though one may have had no previous experience with it.

When everyone was in the same boat and all at sea so far as correcting muscular imbalances was concerned, that is, when everybody dodged the issue or used unsuccessful remedies, all were relatively safe. But the examiner who today ignores binocular imbalances is taking a desperate chance, and will find himself competing under great handicap with his more progressive confreres. Binocular imbalances have existed, do exist and will continue to exist, and get more complex as living conditions get more complex and, willingly or unwillingly, they must be met. The Genothalmic Kratometer affords the simplest and most secure way out.

August
1926

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PREFACE

WHEN one is engaged in a profession or business, whether it be the practice of law, medicine, merchandising, teaching, refraction, or whatever, he must constantly cope with the individual problems of each of his clients. His success is measured by his ability to solve, each in its turn, those individual problems.

The refractionist is peculiarly under compulsion to meet these idiosyncracies of his patients. For never, no matter how extensive his practice, no matter how many individuals he sees in a day, a year or a lifetime, shall he meet two individuals whose binocular problems are exactly alike. He must be equipped, both in knowledge and with apparatus, for studying and differentiating in smallest detail those individual peculiarities.

After many years spent in the practice of refraction, with little success in solving the problems presented by unusually difficult cases; after years of poring over such books as had been written around these questions of binocular difficulties; after years of fruitless search in these texts for some practical hints that might help my patients; after unavailing following of directions set forth in these books for the treatment of "muscular anomalies," I became convinced that something vital was lacking, both in knowledge of binocular functions and in equipment offered the refractionist by manufacturers.

As to the texts, they prove to be almost entirely speculative in character. They are marked by a supreme indifference to the fact that we possess little actual knowledge of the ocular functions, of their mechanism or of the innervational source and pathways by which that mechanism is functionated. There is also a sublime disdain of the few facts that are known. Whenever the writers' theories conflict with known facts, they have the ability to most cheerfully ignore the facts. Mostly, there seems to be a disinclination to learn such facts as are known and which are so easily available in various text books on physiology and nervous anatomy.

So far as specific instructions go, there is an inability to distinguish those smaller points that differentiate cases.

While the more visible symptoms of a group of imbalances are practically identical, there are other symptoms, seemingly minor but in reality of the larger importance, that set some of these cases into classes by themselves and render futile, often make dangerous, the course of treatment advised. An instance in point is the universal advice to give base-out prism exercises when the adduction is low. This recommendation does not take into consideration the many and varied causes of low adduction. It assumes, without physiological basis, that low adduction indicates "weakness of the internal recti," or "low fusional reserves." Both of which ideas are in conflict with physiological knowledge.

The idea that refraction of the eye is a purely optical problem has held back the progress of the science and practice of the art. For refraction, by which we mean the fitting of lenses to bring comfort and good vision, is more than an optical problem. In fact, as we learn more, we find that optics is the minor issue. The problem is physiological and psychological.

As to equipment, manifestly it is built in adaptation to the theories prevalent. If the theories are false, the equipment is weak, unadaptable to the diagnosis and treatment of peculiar cases that do not conform, in their behavior, to the theories.

So I found that the "easy cases" would lend themselves to the treatment prescribed in the books. But there were so many cases that were not helped by these prescriptions, so many that were in fact made more miserable by these treatments, so many that were wandering from practitioner to practitioner seeking relief but to no avail, cases that were classed as "unusual," as "freaks," as "difficult," as "incurable," merely because they did not respond to the treatments generally endorsed, because they did not conform to the theories of imbalances advanced by these speculative writers, that I could come to no other conclusion than that there was an inherent weakness in the whole structure of our general procedure.

It seems now that that weakness lies largely in mistaking the symptom for the thing itself; in calling the symptom the

cause rather than recognizing it as an effect; in attempting to treat the symptom rather than searching for its cause. The manifest imbalances, or "heterophorias," as these symptoms have been inaptly termed, are not the cause of the ocular discomfort, but are results of varied origins. When we come to the clear realization of this, we shall be in better position to offer efficacious treatment. But under the traditional view of binocular imbalances, there was no means of correctly diagnosing a case, nor was there a surety that the traditional methods of treatment would succeed. In fact, failure was more frequent than success.

It was at this stage of discouragement that my attention was called to Hazen and his Kratometer. Up to this time, Hazen's work had been to me no more than that of "another muscle treatment fad." However, in that spirit of desperation when we are "willing to try anything," I possessed myself of a Kratometer and commenced to experiment with it. In a few days I knew I had a new tool, adequate, powerful, superior. Here was a piece of apparatus that could be used to learn more about a pair of eyes than anything that had ever been offered to the refractionist. The revelations, in diagnosis, of the small things that escape notice, that cannot be revealed, in the use of trial frame with loose prisms or with the more complicated batteries of lenses equipped with the inefficient rotary prisms, have set this instrument into a class by itself, supreme to all that has gone before.

While we cannot agree with the theories that Hazen presents in his writings, we see clearly that he had found, probably unknowingly, a fundamental physiological principle and that before the full principle was known to the physiologists themselves. Hence, his inability to command that attention from his colleagues his invention merited.

The past four years have been largely devoted to a mastery of the technique of the Kratometer, to a study of those physiological principles that are fundamental to all muscular activities. One outcome of that work has been the realization

that the value of the Kratometer lies more in its capacity as a diagnostic instrument than in that purpose for which it was first created, as an instrument for giving exercises.

The present book is merely an attempt to set down detailed instructions for using the instrument in diagnosis and training exercises. I have tried, within the limited bounds of this volume, to differentiate symptoms so far as possible. There is no essay at setting forth reasons. In fact, our knowledge of reasons, of causes and effects, is too little to make such an essay practicable or very useful. There have been too many such useless writings in the past. I have little desire to add to them.

We who have been long in practice are somewhat handicapped by traditional theory and method. On the other hand, one may be handicapped by too sure belief in his own thought or by too ready acceptance of newer ideas by others, when these have not been subjected to sufficient critical test. I have tried to avoid either extreme, particularly in the present writing. In the first edition, written in 1926, it seemed wiser to retain many of the terms that have grown into our vocabulary though there was some doubt as to the validity of the theories that brought those expressions into existence. It now seems possible, since there are so many in agreement, to abandon many of those ideas and the expressions describing them. Still, there is much here that is subject to further revision as our knowledge increases and grows more accurate.

If I here seem over enthused concerning one piece of the refractionist's equipment, I crave indulgence. For one who has traveled long and far with little progress toward the goal can be no other than earnest in describing the merits of the vehicle that finally sets him far forward in his quest.

My thanks are due to the many refractionists who, in using the Kratometer, have discovered additional possibilities. Through their co-operation, methods have been developed for caring for imbalances that were long considered hopeless. The methods described here are not the result of one man's lonely work, but the product of the investigations and experiments of many.

R. M. PECKHAM.

Waterbury, Conn.
September, 1928

THE PURPOSE OF THE GENOTHALMIC KRATOMETER

THE Genothalmic Kratometer fills a demand for an instrument, the necessity for which has been recognized for over three decades, that will enable the refractionist to properly care for the many anomalous cases of eye strain that are not relieved by the prescription of glasses. The instrument is the result of many years of study and research, and has been designed to afford a means for caring for the idiosyncracies presented in multitudinous variety in these peculiar cases.

THE KRATOMETER IN DIAGNOSIS

As a diagnostic instrument, the Genothalmic Kratometer enables the refractionist to discover the real underlying causes productive of visual discomfort in many of the obscure cases that have hitherto proved so baffling.

With the Kratometer, it is possible to disclose the full hyperopic error, without the use of atropine, by mechanical relaxation of convergence and inhibition of its control over accommodation.

Relation of convergence to accommodation and the influence of the former over the latter can be determined.

The relation of the latent hyperopia to the latent exophoria can be studied in detail.

The dividing line between the field of relative convergence and the field of convergence-accommodation can be definitely determined and the proportion of the former to the latter, in the induction and abduction tests, so essential in a diagnosis, can be accurately learned; a point that has been impossible with previous instruments.

Determination is possible as to whether the complaint is due to latent hyperopia or to other causes. In the past this has been largely a matter of guesswork, but need be so no longer.

The proportion of the latent hyperopia that is to be corrected in order to relieve the patient can be ascertained. This feature alone makes the Kratometer an indispensable adjunct in the refractionist's examination room.

For the study of hyperphorias and cyclophorias, the Kratometer, and the Kratometer alone, enables the refractionist to differentiate between cause and effect, between true and false hyperphorias and cyclophorias.

The effect on a manifest hyperphoria following the correction of the latent hyperopia can be seen.

The effect of the correction of a manifest hyperphoria on the manifest exophoria, whether the latter is increased or decreased by the vertical prisms, whether it is wiser to use the vertical prism in position of correction or in the reverse position of exercise, is quickly shown.

The Kratometer was the first, is still the only instrument that will accurately measure the vertical ductions.

Causes of stress can be revealed. Once known, they may be eradicated.

THE KRATOMETER IN FUNCTIONAL TRAINING

Exercises with the Kratometer offer a successful method of treating the cause of many of those difficulties in ocular motility that produce eye strain, uncomfortable vision, poor vision, lack of equilibrium, indigestion, headaches, slow focusing, and many other complaints.

Specifically, Kratometer exercises are to be given for:

The cultivation in the nervous centers of proper habits of distribution of innervational and inhibitory impulses in cases of troublesome heterophorias.

The breaking down of unwanted association between convergence and accommodation and the development of the convergence relaxation in accommodative esophoria, which has heretofore been extremely difficult and fraught with much

labor and inconvenience to both refractionist and patient, sometimes has been well-nigh impossible.

The breaking down of unwanted association between convergence and accommodation in those easier cases of latent hyperopia showing manifest orthophoria or exophoria, which, though they can be handled successfully by older equipment, can be brought to comfort and balance much more quickly with Kratometer methods.

The breaking down of the hyper-tonicities of the extrinsic muscles, which make their presence shown by such imbalances as esophoria, hyperphoria, cyclophoria, caused by functional imbalances.

The breaking down of unwanted association between convergence and accommodation, the development of accommodative relaxation, the reduction of the needed minus lenses, in cases of convergence-accommodative, or pseudo-, myopia.

The inhibition of hyper-tonicities of the ciliary, the reduction of the manifest myopia, the obstruction of progressive myopia.

The development of equality of vertical ductions in hyperphoria.

The training of the secondary visual centers in suspension and suppression habits.

The development of binocular adjustments to overcome the possibility of monocular suppression.

The education of the fusional habit and the desire for single binocular vision.

The development of a wide-angle field of single binocular vision with proper accommodative association.

Development of convergence and accommodative amplitudes.

Education of the various functions used in near vision, when several hours of near work cannot be carried on without fatigue.

Development of "speed of vision" and "speed of adjustment" for motorists, typists, etc.

Development of visual acuity in amblyopia ex anopsia.

Development of the fusional habit in certain types of exotropia and esotropia.

Education of the sense of stereoscopic vision, when this is lacking.

The correction, without glasses, of "sub-normal accommodation," or "premature presbyopia," in children and young people, when this apparent error is not structural but innervational.

The education of proper associative habits between convergence and accommodation, when this development has been retarded in the individual's growth.

The restoration of binocular functions when these have been lost during the progress of some febrile or toxic disease.

The development of ocular motility when ductions in all directions are sub-normal.

The establishment of well-traveled neuro-muscular reflex paths when, for any cause, their development has been incomplete.

The ability to maintain, without fatigue, concentrated binocular fixation on one point. Fatigue at the "movies" is due to lack of this ability. In many forms of industrial work this ability is absolutely essential and the productive capacity of the individual is lowered by lack of it. Motor driving calls for this ability, in addition to swift binocular motility.

The removal of those inadequacies of binocular functioning that lead to dizziness, car-sickness, indigestion and nervous exhaustion.

The development of the sense of ocular orientation which includes speed of binocular fixation and the maintenance of equilibrium.

The development of nervous conductivity to a maximum of "increment" with the minimum of "decrement."

The development of muscular "tone" and good health, ease and certainty of contractility and relaxation, with the ability to function without fatigue.

The inhibition of hyper-tonicty in one muscle or group of muscles with the building up of tonicity in the hypo-tonic antagonists, that reciprocal innervations may be balanced and swift.

The development of proper pathways through the fiber tracts, with the obliteration of old pathways, when binocular efficiency is lacking because of incorrect, or inapt, innervational habit.

The facilitation of prompt, balanced, properly directed oculo-motor innervation in response to visuo-sensory stimulation.

The release of conditioning tensions in the ocular muscles that prevent synchronized response to allied vestibular and visual sensations, as in many cases of dizziness, car-sickness and sea-sickness.

The education in co-ordination of all functions of binocular vision, that the individual may become possessed of those advantages normally inherent in the faculty of human vision.

THE GENOTHALMIC KRATOMETER PRINCIPLE

KRATOMETER duction tests and prismatic exercises are based on the physiologic fact that the retinal area whose irritation induces versions, convergence and fusion is in the field surrounding the macula, not in the macula itself. The sense of diplopia aroused in this peripheral field awakens the fusional sense, bringing about the reflex muscular stimulations that lead to bi-macular fixation and fusion.

Versions, or rotations, of the eyes are caused by the appearance off the macula of the image of an object in which we are interested. The reflex arc incited by this leads to those reciprocal innervations and inhibitions of the extrinsic muscles that result in the placement of the fovea beneath the image.

All muscular actions are in proportion to the importance attached to the sensation. The attached importance is in proportion to the vividness of the sensation. A moving object attracts attention, a jumping object attracts more than double the attention that a gliding object attracts. This is the secret of the greater efficiency of Kratometer exercises over those given by swinging lights, or the smooth gliding effected by rotary prisms and various other instruments employing steadily moving objects, whether swung in half arcs, whole circles, or straight lines, whether fast or slow. None of these induce such definite, sharp, rotation to macular fixation as the Kratometer jumps incite.

Nor with any other instrument is every act known and controlled, its certainty insured when the central nervous system can effect the act, or the failure to reach the goal revealed when some obstruction prevents the nervous centers from carrying out the command. For this one reason, the actual knowledge the operator has at every moment of exactly what is occurring, the Kratometer stands out in splendid isolation, far above any device yet constructed for giving ocular exercises.

In reading the printed page, in watching the flight of an aeroplane, in vigilant attention to the road ahead of the speeding automobile, in viewing the passage of hundreds of objects that fly past the window of a moving train, the eyes do not turn in a steady, unbroken movement, but in a series of jumps and minute readjustments, following each other in rapid succession. These jumps are instigated by the passage of the moving object off the macula into the fields immediately surrounding, and the consequent report to the central nervous system of slight diplopias. The reflex of these diplopia sensations is the quick readjustment of the eye positions to macular perception and fusion.

The "pulling power of the muscles," supposedly measured by all devices heretofore invented for the measurement of ductions, is of far less importance than the quick adjusting or "jumping" reflexes. Innervational responsiveness is the desideratum, and "muscular strength" becomes of secondary importance.

In the Kratometer prism movements, the images are "jumped" out of fusion, awakening the fusional impulse and reflexes by a sudden stroke. This "jump," repeated time and time again, each repetition causing reflex activity, establishes the desired habit.

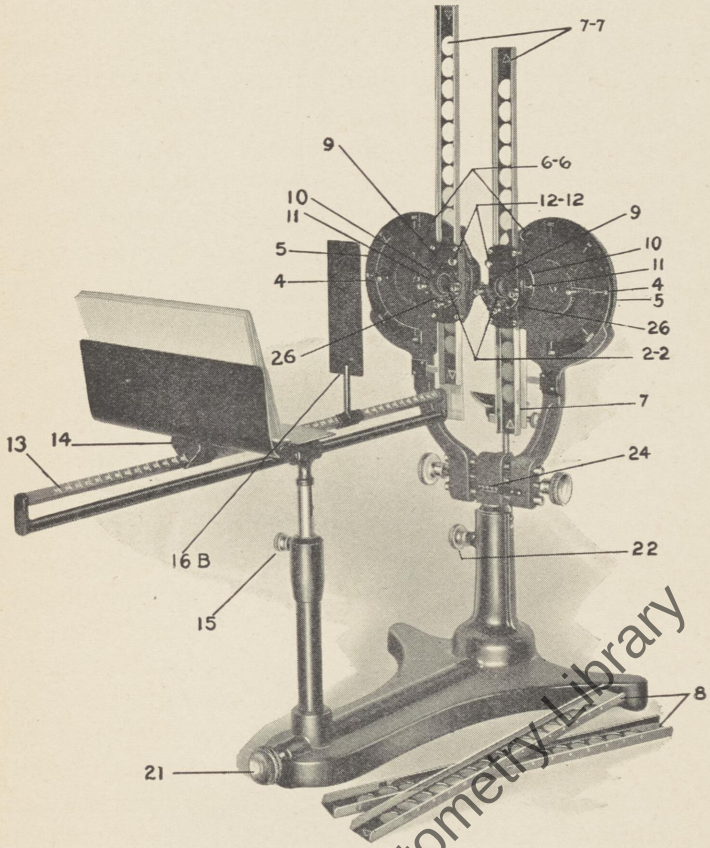
Stimulation of the primary, or retinal, and secondary, or cortical, visual centers, and the establishment of frequently traveled nervous routes between them, increases visual acuity. Thus, Kratometer exercises develop both acuity and fusional habits simultaneously, thus being of particular value in the development of vision and co-ordination with its mate of an amblyopic eye, to whose cortical centers clear vision and the sense of binocularity are unknown.

The adjustments of the Genothalmic Kratometer are so devised that these reflex acts, whose certainty and speed are so essential, can be practised with the eyes in various positions, turned to the side or up or down, thus cultivating the

habit of quick response and speedy adjustment for any position the eyes may be compelled to assume.

The superiority of Kratometer methods is due to the sudden removal of the image from the fovea with a distinct interim between its reappearance in another part of the retina. Subconscious responses in the motor system replace the fovea beneath the image. The surprise element, the subtle distinction that places the Kratometer above all other devices, is a strong factor in awakening slumbering attention. Without conscious endeavor, but with the extreme of efficiency, attention and concentration are enforced, become habitual. With all other devices that have appeared, attention, willingness and ability of the patient to enforce ocular rotations, have been a pre-requisite. When these were lacking, there was no starting point. This handicap is removed now that we have the Kratometer, for with it we can awaken and cultivate these needful faculties.

The Genothalmic Kratometer is the first instrument to utilize the physiologic principles controlling the functions of ocular versions and binocular single vision. This instrument makes possible the correct diagnosis of many puzzling phenomena leading to ocular imbalance and strain, whose origin and interpretation were impossible by older instruments and methods. The Kratometer methods of innervational exercising successfully correct many of these defects, giving comfort to many sufferers for whom previously nothing could be done. And in those milder forms of imbalance which have been successfully treated by the older methods, the Kratometer methods shorten by more than half the time spent in establishing balance.



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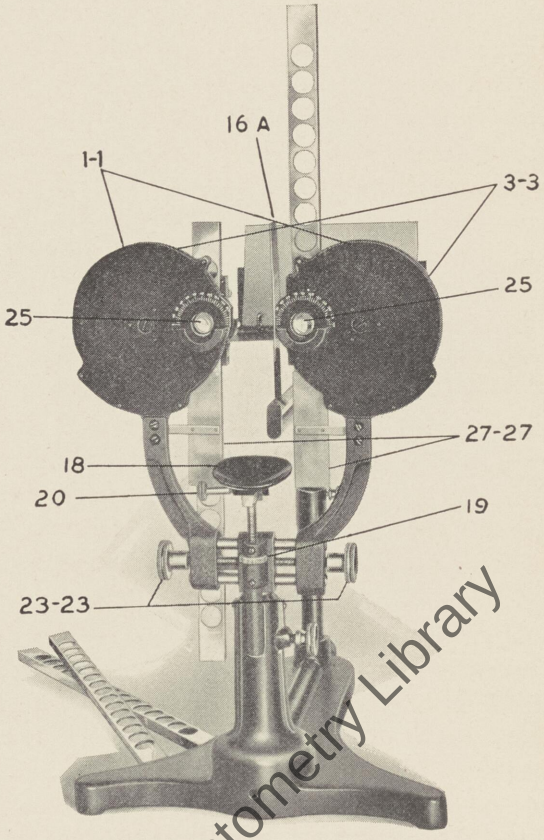
21, Screw for Raising and Lowering Batteries. 22, Screw for Locking Batteries.
24, Pupillary Scale. 26, Three Front Lens Cells.



1-1, Main Batteries. 3-3, Knurled Edges of Rotary Disks.
16-A, Stereoscope Septum Not in Use. 18, Chin Rest.
19, Knurled Nut for Adjusting Chin Rest. 20, Chin Rest Set Screw.
23-23, Pupillary Adjustment Knobs. 25, Three Rear Lens Cells.
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DESCRIPTION OF THE GENOTHALMIC KRATOMETER

NUMBERS IN PARENTHESES REFER TO THE CORRESPONDING NUMBERS IN THE ILLUSTRATIONS ON PAGES 13-14

The Genothalmic Kratometer base supports two main batteries (1–1), each with its sight aperture (2–2). In each battery is a circular rotary disk supplied with nine auxiliaries, viz., an open aperture, six supplemental prisms, 3△, 5△, 10△, 15△, 20△, 25△, a Maddox Rod and a red glass. These rotary disks have knurled edges (3–3) and are easily turned by pressure of the finger against these edges.

The supplemental prisms and the Maddox Rod can be rotated and set at any desired axis. This movement is operated by a convenient axis latch (4–4) which can be turned through the entire circle of 360°. The prism base is thrown into the desired position by setting the axis latch over the word "In," "Out," "Up" or "Down," as found on the prism base recording scale (5–5) on the front of the battery.

The axes of the Maddox Rods are so adjusted that when the axis latch points at up or down the line of light is vertical; when the axis latch is at in or out, the line of light appears horizontal.

In an opening (6–6) near the top of each battery, and in plain view from the operator's position, is registered the auxiliary from the rotary disk that is in position in the sight aperture.

Four prism slides are provided with the instrument, two with horizontal prisms (8–8) and two with vertical prisms (7–7).

Each of the bars with horizontal prisms contains an open aperture succeeded by prisms from 1△ to 13△ in 1△ intervals. An open aperture also succeeds the 13△ prism. Together with the supplemental prisms from the rotary

disks, any BASE-IN or BASE-OUT power from 1 △ to 38 △ over either eye, or any horizontal power from 2 △ to 76 △ over both eyes, in 1 △ steps, can be quickly obtained.

Each of the prism slides with vertical prisms contains an open aperture followed by prisms from 0.25 △ to 3.25 △ in 0.25 △ steps. In combination with the supplemental prisms from the rotary disk any desired prism power from 0.25 △ to 28.25 △ BASE-UP or BASE-DOWN over either eye, or total vertical power from 0.50 △ to 56.50 △ over both eyes, in 0.25 △ graduations, are at quick command. An open aperture in the slide succeeds the 3.25 △ prism.

By combining prisms in horizontal position from the disks with prisms in vertical position from the slides, or vice versa, an infinite number of combinations of vertical and horizontal prisms can be brought into position.

The prism powers are engraved on the sides of the prism slides. The position of the prism base and apex is indicated by a △ engraved on the front of the prism slide.

The prism slides are to be inserted in the adjustable brackets (9-9). The slides are held securely in place by pawls that engage in notches in the slides.

The prism power from the slide that is before the sight aperture can be noted by the operator in a convenient registry opening (10-10) in either the inner or the outer side of the adjustable bracket.

The adjustable brackets, carrying the prism slides, can be angled through an arc of 30° to the right or left of the vertical or horizontal position. When the prism in the slide is exactly at the vertical or horizontal position, the white markers (11–11), one on the circular base of the adjustable bracket, the other on the rigid battery front, marked –0, are in line.

A set screw (12–12) to each bracket holds the prism slide rigidly at any desired angle. When the slide is to be angled away from the vertical position, first loosen this screw.

The prisms are mounted firmly in the slide, insuring positive accuracy of position.

A rod (13) to hold the test chart carrier (14) is mounted in an upright sleeve from the base plate. This rod may be raised or lowered or it may be removed entirely. A set screw (15) in the sleeve holds the rod at any desired height.

The chart holder is free to slide through the entire length of the rod, which is twenty-one inches long and calibrated in inches and centimeters.

The stereoscope septum (16), for use in the diagnosis and treatment of suspensions, suppressions, uncertain fixation, slow fusion, foveal slip, cyclotorsions, lack of stereopsis and other eccentricities, can be adjusted to any position. When this septum is in use, it is turned to parallel the batteries, its purpose being to hide the right side of the stereograph from the left eye of the patient and the left side of the stereograph from the patient's right eye (See 16B). When not in use, it is turned to parallel the rod, and is moved up to the end of the rod next to the batteries, where it cannot obstruct the patient's vision (See 16A).

The chin rest (18) can be adjusted vertically by a knurled nut at (19) and horizontally by the set screw (20), thus affording a comfortable rest for the patient.

Raising or lowering of the batteries is accomplished from the operator's end of the instrument by the screw at (21). The locking screw (22) maintains rigidity. This locking screw should be loosened before adjusting the batteries and tightened immediately thereafter.

The pupillary adjustment is operated from either side by knobs (23–23) and the scale (24) is easily read from the operator's position.

There are three rear lens cells (25), accurately calibrated, for the reception of trial case lens corrections for any existing ametropia or presbyopia.

The three front lens cells (26), also calibrated, are for

the use of cross-cylinder lenses in the accommodative-convergence balance tests, and for the addition of weak trial plus or minus spheres or cylinders in this test, also for the reception of plus or minus spheres and loose prisms whose use may be desirable while giving exercises. If the patient's prescription includes vertical prisms for constant wear, their trial case equivalents may be placed in these front lens cells during exercises of the horizontal functions.

These front cells can be changed at will to receive either size of trial case lenses now in use. The operator will see two sets of screw-holes in the cell body. If he uses the 1½-inch trial case lenses, the screws that support the lenses are to be inserted in the outer screw-holes. Or if he uses the 1¼-inch lenses, the screws should be set in the inner screw-holes.

The rear cells are not adjustable, but are made of the size specified when the instrument is ordered. Should the refractionist wish to change his trial set to lenses of another size, proper rear cells can be purchased, and the exchange from one to the other is easily made by anyone.

If the operator uses trial lenses with 15 mm. opening, these serve well in the rear cells in making the phoria and cross-cylinder tests, but will not be so good for use in the front cells in giving exercises, on account of the restricted lateral fields. The small aperture is no handicap in the rear cells.

Spring clips attached to the lens cells hold cylindrical lenses from turning away from their proper axial position. (Note: In the early models these clips were not supplied. Owners of those models can obtain these clips at a nominal price. They are easily attached.)

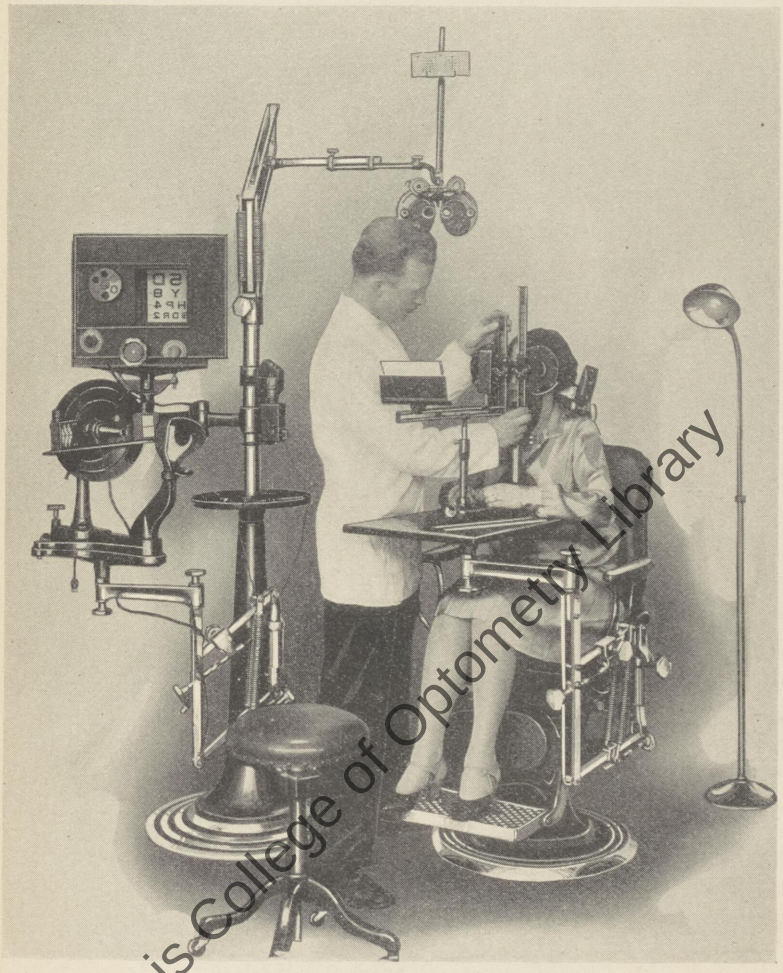
The breath shields (27–27) are removable for sterilization.

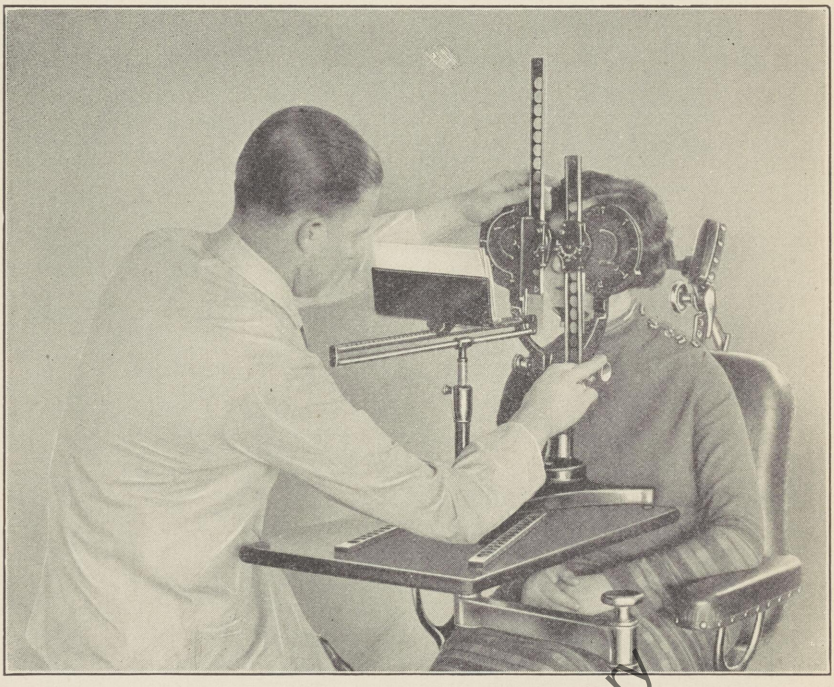
The chart holder is made to keep all the cards used in near point tests and exercises together, preserving them from loss and soiling, maintaining them in correct position and always ready for immediate use.

Cards are provided in sufficient variety for the tests that

are to be made and the exercises that are to be given. But if the refractionist wishes to add others to this collection, they can be easily inserted in the chart holder.

The Genothalmic Kratometer was designed and built to insure the heretofore unobtainable rigidity so essential in giving innervational prism exercises.





KRATOMETER IN USE

OPERATING THE GENOTHALMIC KRATOMETER

THE operator should study the Kratometer adjustments, acquaint himself with their possibilities and develop a method of using the instrument with the minimum of physical effort and the maximum of comfort.

The movement of the prism slides must be rapid and positive. The jump from one prism to the next must be made as quickly as possible. There may be no lagging in the slide movement. So the operator must find that position of body and arms that will enable him to push or pull the slide through the bracket in a quick, positive jump.

The same is true of the rotation of the rotary disks. In these the prism power is increased by turning the top of the disk outward, away from the nose. For this, we recommend that the hands rest on the outer battery edges, slightly above the center. The battery is grasped between thumb and middle finger, the forefinger extended along the knurled edge of the rotary disk. A quick drawing in of the forefinger turns the disk to the next higher prism power. In turning the disk in the opposite direction to reduce the prism power, the same position of the hand is taken, but with the forefinger bent, the cushion of the last joint pressed against the disk edge, a quick shove of the finger pushes the disk over to the next lower prism.

While every individual will find a position most suitable for himself, we recommend that the operator seat himself at one side and well to the front of the instrument. Use a high Genothalmic stool to bring the arms in comfortable position, so there shall follow no fatigue in operating the prism slides.

The right handed individual will find his best position at the left side of the instrument. The left hand rests on the top of the right battery (over the patient's right eye.) The slide is grasped by the thumb and finger and pulled upward or pushed downward. The third finger of the right hand rests on the left knob of the pupillary adjustment screw, the slide is held by the thumb and fore and middle fingers and pushed upward or pulled downward. These positions afford a leverage that will make quick movements of the slides possible.

In both rotary disk and slide movements, a click of the self-adjusting pawls notifies the operator when the prism is in true position.

With the prism slides at base-out and set at zero, the right slide extends upward from its bracket and the left slide extends downward from its bracket. We recommend that these slides be always used in this position, excepting in

the distance phoria test. When prism base-in is desired, turn in 5△ or 10△ base-in from the rotary disks, neutralize this with 5△ or 10△ base-out of the slides, then reduce the slide power step by step. At any time, with this arrangement the effective base-in power before the sight aperture is the difference between the powers of the rotary disks and the prism slides. This custom will prove a great saving in time, as it does away with the necessity of withdrawing and resetting the prism slides.

THE POSITION OF THE PATIENT

The patient must be seated comfortably, avoiding any cramped or tiresome position. In particular, there must be no artificial posture of the head which might tend to cramp the neck and bring pressure of the cervical bones on the cervical section of the spinal cord, for such pressure will interrupt the flow of neural energy to the intrinsic muscles of the eyes.

As so much time is wasted in adjusting the ordinary table to this necessary comfortable position, we strongly advise the use of the Kratometer Adjustable Attachment with the Genothalmic Refractionist Chair.

This is swung into position at the correct height and angle immediately, with no time lost in adjusting screws. When necessary, supplemental adjustments of the Kratometer batteries is but the matter of a moment. In general, it will be found convenient to keep the batteries raised to their full height if the instrument is used with this adjusting bracket. Only with very stout persons will there then be any need of individual adjustments. The use of the Genothalmic Chair and Kratometer Adjustable Attachment will be found an economy when the element of time saving is considered.

The patient's head must be well up, eyes in the primary position. He must not be permitted to tilt the forehead forwards for then the eyes will be turned slightly upward,

which is contrary to their natural convergence movement. Both distance and near targets should set somewhat below the level of the patient's eyes, so that his eyes will turn downward a little in the normal visual and convergence position.

THE DYNAMIC DISTANCE PHORIA TEST

THIS is the first step in the refractive examination. It should be made without correcting lenses if patient has not heretofore worn distance glasses, or with the old correction if he has worn glasses for some time. In the latter event, place trial case lenses equivalent to this old correction in the rear lens cells of the Kratometer.

Lower the reading test rod as much as possible. Otherwise, the upper edge of the chart holder will attract some attention, may incite the accommodation appreciably, thus the phoria test will be rendered inaccurate.

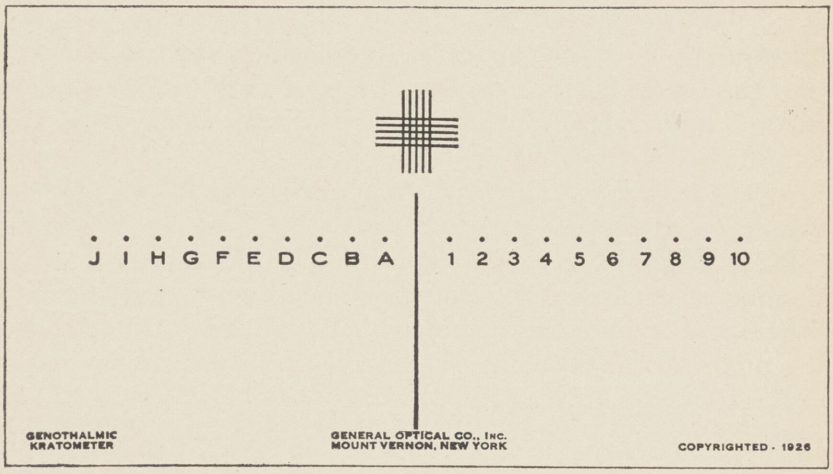
Adjust the pupillary distance of the batteries to conform to the patient's as used in distant vision if no glasses have been used or to the pupillary distance of the old glasses if any have been used.

Set the axis latch of right battery at *base-up*, and the axis latch of left battery at *base-down*. The disk readings are left at OPEN.

Adjust the instrument in comfortable position before the patient and direct his attention to Chart No. 1, to be used at 6 meters, or greater distance if possible.

Chart No. 1 is printed with both "direct reading" and "reversed" characters so that the tests may be made either without or with a mirror. The table of scale readings given on page 25 enables the refractionist to employ the chart at any distance.

Rotate the left rotary disk to 3△, which will fall into position base-down. Ask patient if he now sees two crosses, one above the other. If not, turn in the 3△ of the right



Charts Nos. 1 and 2

rotary disk, which will come in base-up. If he still does not see two images, turn the left disk to 5△. If this does not create vertical diplopia, turn in the 5△ of the right disk. If he still does not see double, it is a case of suspension, which will be covered in a later section.

If the vision is so poor that the cross cannot be seen at six meters or more, bring it nearer to the patient, near enough so he can just about distinguish that there is a cross, not necessarily the individual lines composing the cross. It is then within the range of his accommodation, and the test will be dynamic. If one eye be amblyopic it must be favored in this way.

In cases of extremely poor vision, resort may be made to a light and the Maddox Rod, or a light with white glass over one eye and red glass over the other. Such tests are not dynamic and do not give accurate accommodative phoria amounts, but they serve as guides in cases of very poor vision.

When vertical diplopia has been established, the upper image belongs to the left eye, the lower image to the right

eye. Ask the patient if the upper image is directly over the lower image or to one side. If to one side, which side?

If the two images are in exact vertical alignment, it proves accommodative orthophoria. If the upper image is to the left of the lower image, it is a case of esophoria. If the upper image is to the right of the lower image, we have manifest exophoria.

Next estimate the scale amount of the heterophoria. The periods on the scale of Chart No. 1 are so spaced that at different distances the spacings are equivalent to the following prismatic displacements:

At 1 meter	—3.00△	At 5 meters	—0.60△
" 2 meters	—1.50△	" **6** "	**—0.50△**
" 3 "	—1.00△	" 8 "	—0.37△
" 4 "	—0.75△	" 10 "	—0.30△

At 12 meters —0.25△

In esophoria, the long line or "stem" of the upper target will seem to extend down into the lower row of letters, it will pass through or near a letter. Ask the patient what letter of the lower row this upper stem is near. If it is at A, and the test is at 6 meters, there is a scale reading of 0.50△ of esophoria; if the line seems to run through B, there is 1△ of esophoria; if it is between A and B, there is about 0.75 esophoria, etc.

In manifest exophoria, the long line or "stem" of the upper target will seem to extend down and pass through or near one of the numerals of the lower row. If it seems to pass through 1, there is 0.50 △ of manifest exophoria at 6 meters; if the stem runs through 3, there is 1.50 △ of manifest exophoria; if it passes between 3 and 4, there is 1.75 △ manifest exophoria, etc.

The next step is to measure the promptness or sluggishness of response to prismatic assistance.

In a case of esophoria, insert one of the 1△ prism slides

into the left bracket with the prisms at *base-out*. Push the slide down one notch, thus placing 1 △ base-out over the left eye. Ask the patient if the upper cross moved to the right, and, if so, how much? If there is 1 △ or less of esophoria, and the upper cross moves over, under the assistance of the 1 △, so that it goes to the right of the lower target, innervational response is good. Or, with 2 △ of esophoria, if the two crosses are put into vertical alignment with the assistance of only 1 △ base-out, functional response is satisfactory. But if the amount of esophoria by the scale reading, and the amount of prism base-out required to align the two objects, are equal, we may seriously question the responsiveness of the innervational centers. And if more prism is required for vertical alignment than the amount of the esophoria indicated by the scale reading, we can surely know that innervational response is sluggish, and that Kratometer exercises are in order.

If the case is one of manifest exophoria, insert one of the 1 △ prism bars into the right bracket with the prism base-in. Proceed as in the preceding paragraph. Slide the bar down one step at a time, pausing at each change for the eyes to adjust themselves, and asking how much the upper cross has moved to the left. If less prism power is needed for vertical alignment than the amount of exophoria indicated by the scale reading, functional responsiveness to stimuli is excellent. If the prism power equals the scale reading, responsive ability is fair. If more prism than the scale reading is necessary for vertical alignment, nervous response is slow and the need for Kratometer exercises is indicated.

After the refraction is completed, and the distance corrections ascertained, repeat these tests, taking care that the pupillary distance of the batteries conforms to the patient's as used in distant vision. With the new correction on, if there was accommodative orthophoria at the first test, there should be the same in the second test with the new lenses.

If the new correction is plus and an artificial manifest exophoria has been created by these, either the plus must be reduced or base-in prisms prescribed or Kratometer exercises given.

If the case proves to be one of latent hyperopia, base-in prisms are to be prescribed. But if it is found to be a case of immaturity of the convergence-accommodation function, the plus must be reduced, base-out prisms for temporary wear prescribed and Kratometer exercises with base-out prisms are in order.

If a previous manifest exophoria is increased by the new plus correction, the same routine is to be followed as in the immediately preceding paragraph.

Accommodative esophoria, if some still persists with the correction in place, should show a diminution in scale reading and a better response to the trial by base-out prisms as described in paragraphs above.

We occasionally meet in the first phoria test an exophoria that disappears or is lessened in amount after the correcting plus lenses are placed before the eyes. This is an exhaustion exophoria, and seldom needs further treatment than the exact correction of the refractive error.

A similar manifest exophoria is that which may be described as a poor motor response due to an imperfect visual sensation. These cases must be refracted with scrupulous care that an absolutely sharp image may be presented to the visual centers. The Genothalmic Visual Test Cabinet with its controllable illumination, is indispensable for the proper conduct of the examination when we have such cases to correct. For only by subjective tests under low illumination is the finest possible correction to be learned. With an accurately focussed image, thus obtained, this type of exophoria will disappear. (Page [illegible])

Manifest exophorias and esophorias must be regarded as symptoms, not as causes. They are not to be corrected but the cause is to be found and removed.

DYNAMIC PHORIA TEST AT THE READING POINT

THE procedure is the same as in the dynamic phoria test at distance. Use Chart No. 2 (illustrated on page 19). The spacings of the periods on this card at various distances are equivalent to prismatic power as follows:

At 100 cm.	—0.70△	At 30 cm.	—2.33△
" 70 "	—1.00△	" 28 "	—2.50△
" 50 "	—1.40△	" 25 "	—2.80△
" 40 "	—1.75△	" 23 "	—3.00△
" **35** "	**—2.00△**	" 20 "	—3.50△
" 33 "	—2.12△		

The pupillary adjustment of the batteries should be made about 4 mm. less than the patient's distance interpupillary distance.

The usual reading distance is about 35 cm. But ascertain the individual's accustomed reading distance, and make the dynamic phoria test at that point.

Usually, there is a little more manifest exophoria at the reading point than at the far distance. The difference in amount between the distance phoria and the reading point phoria is, when not due to exhaustion, the physiological exophoria, and indicates incomplete development of functional relaxation of the external recti. If it amounts to more than 3△ or 4△, this excessive exophoria is often due to exhaustion from the lack of sufficient plus correction; we may, however, suspect hysteria or toxemias.

If the patient has been wearing reading glasses, make the dynamic phoria test with that correction in the rear lens cells of the Kratometer. If he has not been wearing a reading correction, but has been using distance glasses, make the test with this former distance correction in the Kratometer.

Interpretation of these tests is the same as in the distance tests. Compare the scale readings with the amount of prism

needed to align vertically the two targets. Often response is good at distance but poor at near. The amount of accommodative exophoria is of less moment than the innervational response to the assistive stimulus of base-in prisms.

In exophoria from exhaustion, the response to prismatic assistance will at once show improvement when the correct reading lenses are put in front of the eyes. And usually the amount of exophoria is decreased at once by these correcting lenses. But of the physiological exophoria, there should be no change in either amount or in response by the correction of the presbyopia or the refractive error. (Page 125.)

In presbyopia, if the addition of sufficient plus lens strength to enable the patient to read fine type should increase the exophoria, it may be inferred that not sufficient plus has been included in the distance correction, there is latent hyperopia and latent exophoria. Relax the convergence and break down the association of convergence and accommodation at the distance by Kratometer exercises and the temporary prescription of base-in prisms. See the sections on "Exercises for Convergence Relaxation" (page 69); and the "Cross Cylinder Tests" (page 99).

The above is true, generally, for middle-aged persons. But often, especially in women of past the age of sixty, occasionally in men, this finding will be associated with vegetative system imbalances, reflected in ciliary hyper-tonicities. These must not be mistaken for imbalances arising in ocular functioning. Temporary base-in prisms may be given if they improve vision or comfort, but the patient should be referred to the proper specialist that the cause of the imbalance may be eliminated.

If the amplitudes of accommodation and convergence are both sub-normal, innervational exercises with the Kratometer, the target set at the reading distance, should be instituted. See the section on "Exercises for Developing the

Convergence-Accommodation Function." (Page 80.)

For test for low tonicity at the reading distance, use Chart No. 3 as described on pages 53–55.

PHORIA TESTS WITH THE MADDOX ROD

HORIZONTAL TEST

Use a small spot light at the distance. The smaller the better. Darken the room. Let there be no source of light that may cause an extra streak in the Maddox Rod, for this will produce confusion and uncertainty. Adjust the instrument in position and turn in the Maddox Rod over the eye with the better vision, leaving the poor eye fixing the light. Adjust the axis latch at either base-up or base-down. The streak will now appear vertical.

If the Rod is over the left eye, and the streak appears to the patient to be at the right of the light, exophoria is indicated. With the horizontal slide at base-in, find the amount of prism that will bring the streak through the center of the light.

With the Rod over the left eye, if the streak appears to the left of the light, esophoria is indicated. With the horizontal slide at base-out, find the amount of prism that will set the streak into the center of the light.

With the Rod over the right eye, exophoria is indicated when the streak is to the left of the light; and in esophoria, the streak is to the right.

Orthophoria is manifest when the streak cuts the center of the light without prismatic aid.

Many persons will have difficulty in seeing both light and streak at the same time. Others will see them both, then one or the other may disappear. This is evidence of suspension.

As an uncertain and unknown amount of accommodation is in force when the Maddox tests are used, these will not be

dynamic tests, nor will the accommodative phorias be correctly indicated. With the accommodation suspended with atropine, the Maddox Rod will indicate the static phoria with a fair degree of exactness. For this reason, we recommend that the dynamic phoria test described previously be used when atropine is not employed.

VERTICAL TEST

Turn the axis latch to either base-out or base-in. The streak is now horizontal. In vertical balance, the streak will cut the center of the light.

With Rod over the left eye, if the streak is below the light, the left eye is turning up, or the right eye is turning down. With the vertical prism slide, find how much prism base-down over the left eye, or base-up over the right eye, will bring the streak to the center of the light.

With Rod over the left eye, if the streak is above the light, the left eye is turning down, or the right eye is turning up. With the vertical prism slide, find how much prism base-up over the left eye, or base-down over the right eye, will bring the streak to the center of the light.

With Rod over the right eye, if the streak is below the light, the right eye is turning up or the left eye is turning down; if the streak is above the light, the right eye is turning down or the left eye is turning up.

Such findings of evident hyperphoria must not be accepted as proof of true hyperphoria. These findings are merely evidence of lack of innervational control, and are as often due to convergence troubles and to accommodative-convergence imbalances as to faults in the vertical muscles.

In true hyperphoria, the amount of the manifest imbalance is the same at all distances. The test at the reading point is easily made by removing the cap from the Genothalmic Skiascope, thus exposing the lamp which will serve as the target at the reading distance.

When hyperphoria is found with the maddox test, the vertical ductions will show whether this is a true or false hyperphoria. (Page 44; page 55.)

THE ABDUCTION TESTS

THE DISTANCE ABDUCTION

ABDUCTION should be considered as the ability of the convergence to relax. The amount of abduction at distance is always important. Also, after the point of diplopia is reached, measuring the total of the abduction, the prisms should be slowly reduced and the point of recovery, or the prism power at which the single image is regained, must be noted. The point of recovery should be within 2△ or 3△ of the breaking point. If the prisms must be reduced more than this before the single image is regained, a condition of tension, or strain, is indicated. The cause must be searched out and removed.

The breaking and recovery points in the distance abduction test can be used for determining the amount of base-in prism to be prescribed for inhibiting the hyper-tonicity of esophoria; for repressing convergence-accommodation in cases of latent hyperopia; for enforcing relaxation to reduce myopia or to restrict the development of progressive myopia.

A distance abduction of 6△ to 8△ with but slight reduction to the recovery point may be considered satisfactory. Less than this is indicative of stress; more than this usually indicates latent hyperopia; in myopia with high distance abduction, it will be found that a considerable proportion of the manifest myopia can be reduced with improvement in vision and comfort.

Place the distance correction in the rear cells. Adjust the pupillary distance of the instrument to the same as the patient's for distance vision.

Set both rotary disks at 5△ *base-in*. Insert the prism slides with prism *base-out*, adjusting them at 5△. You

now have 0△ before the sight apertures. Make the test at 6 meters or more, using Chart No. 1.

Pull the right slide up and the left slide down. Operate both prism slides simultaneously, giving equal prismatic power to the two eyes. Allow a second or two between each change of prism power

If zero of the prism slides is reached (giving effective power of 10△ *base-in* from the disks), without causing diplopia, move both slides to 10△ *base-out* and turn in 10△ *base-in* from both rotary disks. You again have 0△ before the sight aperture. Once more reduce the prism power of the slides, until diplopia results. The ability of the central nervous system to permit relaxation, which is called the abduction, is the *difference* between the *base-in* of the disks and the *base-out* of the slides.

If the operator prefers, he may make the abduction test with the rotary disks set at open, with both prism slides set bases-in, starting with the open apertures. But as in many cases of nervous tension it is impossible for the patient to recover the single image until the prisms are reduced not only to zero but carried past zero to some base-out position, we find that time is saved by using the combinations of disks and slides described in the preceding paragraphs.

The esophore should have a convergence relaxation of four or five times the amount of the manifest esophoria to avoid headaches. If there is an esophoria of 3△, there should be present a possible relaxation of at least 12△. If this proportion is shown in the abduction test, there is, as a rule, comparative freedom from discomfort, particularly if the larger part of the total abduction is in the field of the relative convergence relaxation.

To the above there is one exception. Often with patients who suffer from periodic headache, similar to migraine headaches, the total abduction is quite high, recovery point good,

but in these cases the proportion of relative convergence is low. (See section on Relative Convergence. Page 112.)

In all cases of esophoria, prescribe for constant wear one-third of the prism power at which the single image is recovered. For example, if the breaking point (diplopia) is at 8 △ with recovery at 6 △, 2 △, divided equally between the two eyes should be prescribed. This will inhibit the hyper-tonicity of the convergence muscles, divert the flow of tonicity to the external recti, build up the tonicity of the latter, bring immediate relief from headache. To prescribe more than this amount in cases of latent hyperopia is apt to prove disturbing because of the change in the patient's sense of perspective when too strong base-in prisms are used.

In all cases of myopia, prescribe at once the full value of the recovery point as base-in prism, divided equally between the two eyes. For example, if the break (diplopia) is at 12 △ with recovery at 8 △, prescribe for constant wear this 8 △. Myopes will not experience a change in perspective because of high prisms. It will be found that such prisms will improve vision and generally will reduce the manifest myopia quite notably.

Whenever base-in prisms are prescribed, give ten to fifteen minutes base-in exercises with the Kratometer immediately before adjusting the finished glasses. This will prevent any tendency to diplopia or other possible annoyance.

Abduction measurements with the Kratometer are usually higher than with rotary prisms, for the latter have an oblique value, causing slightly oblique eye rotations, introducing unknown factors of strain. Kratometer measurements give definite information unknown to other methods.

Some esophores have the unfortunate habit of suppressing one image the moment a slight diplopia occurs, rather than to make the necessary effort of convergence relaxation. The operator must watch this habit, for if one image is suppressed, prism base-in can be added indefinitely without diplopia occurring. If one image is suppressed, the target

will seem to move in the direction of the prismatic displacement of the image as it appears to the non-suppressed eye.

If the right eye's image is suppressed, the target will appear to travel to the left. If the left eye's image is suppressed, the target will apparently move to the right. Therefore, the operator should warn the patient to speak the instant the target seems to move to right or left. The target should appear to remain in the center, and will become blurred as the prism base-in increases in power. The addition of more plus sphere usually clears the image somewhat, especially if the accommodation relaxes as we wish it to.

Suspension in myopia causes the same effect of the target's seeming to move to one side, and will have to be guarded against.

If the target does seem to move over to one side, hold the hand in front of the seeing eye, when the suppressed or suspended eye will resume vision. On uncovering both eyes, usually two images will be seen. Reduce prism power until one image is seen in the center.

The habits of suppression and suspension are sometimes very pronounced, and will then reveal themselves in the suspension tests. Again, the suspension occurs very rarely and persists for only a fraction of a second. It is this latter type that the operator must guard against in all duction tests and exercises.

Warning that but one eye is actively concerned in the test is given when the test object seems to move to one side, or when the image does not become blurred when the prisms are increased above the relative convergence point. Therefore, the patient must be carefully instructed to speak when the object seems to move and when it begins to blur.

ABDUCTION AT NEAR

The abduction test at the reading, or near work point, can be used in studying the relations of convergence to accom-

modation, the proportions of latent exophoria to latent hyperopia, the disclosing of latent hyperopia, the determination of the portion of the latent hyperopia that must be corrected to give comfort. (See Convergence-Accommodation Relations, page 99; Relative Convergence, page 112.)

Use the methods detailed above, under the Distance Abduction Test. Use a small picture, such as Kratometer Chart No. 11, or a few short lines of printed matter. Newspaper print is better than fine printing on high grade paper, for the blurring point shows up more accurately. The test is made with the patient's old correction, if he has worn one, in the rear lens cells of the Kratometer.

There are three points to be noted: 1st, the point at which the target commences to blur, this being the division between the relative convergence field and the convergence-accommodation field; 2nd, the point of diplopia; 3rd, the point of recovery.

The total abduction at near must equal the amount of convergence used at the reading distance plus the distance abduction. For example, if the test is made at 40 cm. (16 inches), the patient is using 2.5 meter-angles of convergence. If the interpupillary distance is 60 mm., this equals 15 △. If the distance abduction is 6 △, then 21 △ is the minimum near abduction that we may tolerate. If the distance abduction is 8 △, then there must be a near abduction of 23 △. If the interpupillary distance is 63, 65, 70 mm., or whatever, the near abduction must be in proportion to the meter-angle of reading point convergence plus the distance abduction. If the reading abduction is less than this minimum requirement, the tension must be broken down. Base-in prism segments and Kratometer exercises are needed, unless it is a case of latent hyperopia, in which event the needed plus must be prescribed.

The recovery point, as one of the items of diagnosis, is fully as important as the breaking point.

Reduce the base-out prism 1 △ at a step, until the patient sees the single image, recovers single binocular vision. It is a favorable sign if the recovery occurs with a reduction of but 1 △, 2 △ or 3 △. It is a very unfavorable symptom if the prisms must be reduced more than this for recovery. This is true in both the distance and near abduction tests. It is better to find a rather low total abduction with quick recovery than to make a high abduction with poor recovery.

If near abduction is poor, by the above standard, put a pair of plus spheres, 1.00 D. or 1.50 D., in the lens cells of the Kratometer and find if the abduction is thereby improved. Both breaking point and recovery may be better, or the breaking point may not at first step be much increased, but the recovery will be quicker. In either event, the existence of troublesome latent hyperopia is proved, the need of plus lenses definitely ascertained. In myopia, this improvement would indicate that with proper treatment the manifest error could be decreased.

If the use of plus spheres does not improve total abduction or recovery, the cause of the poor abduction and of the eye distress cannot be attributed to latent hyperopia. Sometimes the plus spheres make the abduction poorer, either decreasing the total or giving a still lower recovery point. Then we have definitely eliminated latent hyperopia as the cause of the low abduction, the tension is from some other source. It is usually found originating in some visceral imbalance.

The point at which the image commences to blur indicates the end of the relative convergence relaxation. When the image blurs, plus spheres will clear it, indicating that the accommodation has relaxed. In this way the latent hyperopia can be determined. (See Convergence-Accommodation Relations, page 99; Differential Diagnosis, page 114). It will be found that in the comfortable pair of eyes the relative convergence field is about two-thirds of the total abduction and that when there is discomfort from latent hyperopia the rela-

tive convergence field is very much less than two-thirds of the total abduction.

THE INDUCTION (ADDUCTION) TESTS

(Note: On account of the similarity of sound of "Ab" and "Ad," we suggest the substitution of the word "Induction" for "Adduction.")

While recent researches make us seriously doubt many of the theories that have prevailed in the past concerning the meaning of the induction tests, such as "Strength of the internal recti," "Reserve strength," "Reserve nervous energy," "Convergence reserve," "Fusional reserve," and so on, yet there is no doubt but that a study of the inductive ability is of value in some cases.

The following is but little more than a description of the manipulation of the Kratometer in making the induction tests, for the guidance of those who desire to use it for that purpose, with but few comments on the possible meanings of the findings.

Induction tests should never precede abduction tests. Base-out prisms tend to increase tensions if there be any. Base-in prisms tend to relax tensions. If induction tests precede abduction tests, then the latter are apt to show less than their real value, particularly when there is hyper-tonicity of the in-turning muscles, as in esophoria.

Induction need not be taken in esophoria, for in this imbalance only the abduction is of importance.

Induction should never be taken in myopia, for the ciliary hyper-tonicity might be increased by this added incitation to convergence and convergence-accommodative effort.

If latent hyperopia is proved in the abduction tests, it is then unnecessary to make the induction test. For even if the induction is low, as it very often is in latent hyperopia, that fact would have no diagnostic value. Give base-in exercises

with the Kratometer, break up the close association of convergence and accommodation, deliver the latter from the dominance of the former, so that the latent hyperopia becomes manifest and correctible with plus lenses, then the induction will increase without further attention.

In cases of low tonicity, where the high exophoria is definitely proved not to be caused from exhaustion due to the lack of plus lenses, it is probably wise to study the induction.

Set the pupillary adjustment scale at the patient's distance interpupillary measurement. Set the rotary disks at OPEN and the axis latches at *base-out*. Insert both prism slides in the brackets, with the prisms *base-out*, adjusting them at *zero*.

When making the near induction test, it is advisable to set the pupillary adjustment scale at 4 to 6 mm. less than the distance measurement.

Operate both slides at the same time. Take the induction four or five times in quick succession without permitting an interval of rest.

As the first test, use the horizontal prism slides, commencing at zero and increasing the prism power by increments of 1 △ over each eye. Advance the two slides simultaneously, pausing for about a second between each jump, continuing until the patient sees two targets. The true reserve is measured by the ability to maintain one clear image. Blurring commences a few points before the actual break into two clear images.

When the induction power is greater than the 26 △ of the two slides, return the slides to zero, turn in as much from the rotary disks as can be overcome (equal power to the two eyes), then add the steps from the slides. The sum of the prisms used from disks and slides is the measure of the reserve induction.

On reaching the point of diplopia, do not permit the patient to withdraw from the instrument, but immediately com-

mence the reduction of prism power, one step at a time, and alternating between the two eyes. Note at what prism strength he is able once more to pick up the single image. If he can overcome considerable prism power before diplopia occurs, and can recover the single image after a slight reduction of the prisms, innervational response and quickness of adjustment are good. But if the prisms must be reduced almost to zero before he can re-fuse the images, we have evidence of tension and stress. In these cases, base-in exercises with the Kratometer will break up these tensions and the induction will then be good. But base-out exercises are prone to increase the tension and should be avoided.

After the first induction test, do not permit the patient to rest, but return at once to zero and repeat the test. Note again the total power obtained and the point at which he recovers single vision. If the finding in the second test is less than in the first test, it shows susceptibility to fatigue, and without doubt Kratometer exercises will be beneficial.

If the second test proves as good or better than the first, that is an encouraging sign. But return to zero once more and make a third test, thus getting a better knowledge of his ability to withstand fatiguing work. If the third test is as good as the first two, we can feel greatly encouraged as to his ability to do a day's close work without fatigue. (Page 151.)

Make the fourth test at a rapid rate. Allow only the briefest pause between prism jumps. This is a speed test, and must be made fast. An individual with good innervational adaptability and quick adjusting habits will take care of nearly as much prism power under the speed test as under the previous tests in which ample time was allowed for recovery. But the one with poor resources will fail badly under this test, especially as it is to be made under somewhat fatigued conditions. If the first "speed" test makes a good showing, repeat two or three times in quick succession, to see if patient can continue work without fatigue. If the first duc-

tion tests bring on fatigue, do not make any more, cease at once, for you have discovered what you wish to know.

There is no set amount of reserve induction that will indicate whether or not an individual has the required innervational freedom. While the ideal is around 40△ to 50△, there are many with much less reserve than this who are perfectly comfortable. And there are others who will show ability to overcome considerable amount of prism base-out, who are very uncomfortable when they are compelled to maintain vision at one point for a considerable length of time.

The findings of the phoria and duction tests are to be studied in detail and in comparison. If the phoria test shows some exophoria, but less prism is required for alignment of the two images than the amount indicated by the scale reading, and if the induction test shows a fair amount of inductive power with quick recovery to single vision as the prisms are decreased after diplopia occurs, and if in each succeeding duction test as good a showing is made as in the preceding ones, and if the speed duction tests make a good showing, we need not worry if the *amount* of the induction reserve is not high. But, if the exophoria is increased by the addition of the plus lenses that correct the monocular refractive errors, if there is not quick recovery from diplopia in the induction tests made as above described, or if there is fatigue shown in repeated induction tests, then innervational exercises ought to be given, regardless of the amount of "pulling power" shown in the first induction test. It is the *quality* of responsiveness that is essential, irrespective of the *quantity* of prism power overcome.

As in the abduction test, warn the patient to speak at once if the image seems to move away from the center, and to advise you when the image begins to blur. Blurring commences, as a rule, within two or three steps of actual diplopia.

With individuals possessing a high convergence amplitude,

it is possible to so much increase the base-out prism power that the object is displaced to such a degree that it becomes invisible to one or the other of the eyes. Then the operator continues to advance prism power under the impression that he is measuring induction, when, in fact, only one eye is following the image, while the other eye is looking at a blank piece of paper in the near test, or at the wall of the room in the distance test. This occurrence is more apt to happen if much more prism is used over one of the eyes than over the other. Therefore, we advise the equal division of prismatic power between the two eyes.

Some persons will realize that "there is something wrong." They will state that they seem to be using one eye only. Others will not notice the disappearance of the test object from one eye while the prisms are being increased, but when the prisms are reduced they will see a second image coming in from one side.

There are two possible causes explanatory of this difficulty. The sight openings may be too widely separated. Or the patient may not be well positioned, he may be a little to one side, or he may not be squarely facing the instrument. Or one eye may be farther from the nose than the other, in which event the instrument should, of course, be so adjusted that the eyes center in the sight openings.

As a check against this occurrence, occlude the left eye and turn in 20△ base-out over the right, asking if the test object is in full view of the right eye with this prism in place. If not, readjust the instrument. Then occlude the right eye, turn in 20△ base-out over the left, make sure that the test object is in full view to this eye. Check both eyes once more, and when the adjustment is satisfactory, turn the 20△ prisms out of the sight openings, and proceed with test or exercises.

This difficulty seldom arises, but we give this attention to

it so that when it does occur the operator will know the cause and the remedy.

Nearly all persons with convergence difficulty are more or less inclined toward occasional lapses of vision in one eye or the other.

If one eye suspends while testing or exercising with base-out prisms, the image will appear to move to the side of the suspending eye. If the right eye suspends, the prismatic effect in front of the left eye will make that eye's image move to the right. If the left eye suspends, the right eye's image seems to move to the left. This is just opposite to the effect when suspension or suppression occurs when working with base-in prisms.

Instruct the patient to advise you if the object seems to move to one side or the other. When there is no suspension, the object remains in the center, seems to come nearer and blurs as the base-out prism power increases, and seems to recede and grow plainer as this prism power is decreased. If, while the induction is being taken, the image grows blurred, then suddenly becomes plain, suspension has occurred. It seldom, save in very bad cases, occurs while the prisms are being decreased. Routine for suspension tests and treatments is given in succeeding sections. (Page 47.)

The operator must ever be alert that he may detect possible suspension. For it might be possible to unknowingly credit the patient with a high induction reserve when he really has very little, one eye or the other having suspended when the least effort of convergence was demanded. Always impress on the patient that he shall speak if the object seems to move to one side. If this occurs, reduce the prism power to zero and start over again, allowing long pauses between prism jumps. If the habit is persistent, turn at once to the Suspension Tests. (Page 47.)

Sometimes a patient will see two test objects on first looking through the sight openings, even though there is no dis-

placing prism in place. This is not conclusive evidence of heterophoria nor of functional insufficiencies. It is indicative of low tonicity, exercises are in order.

Ocassionally it will happen, when measuring the induction or while giving base-out exercises that we carry the base-out prisms up to the point of diplopia, then reduce to the recovery of the single image, then reduce toward zero, but before reaching zero diplopia once more occurs. This is an indication of hyper-tonicity, increased by the base-out prism demands for more convergence innervation, carried to the point where total relaxation is practically impossible. In such event, reverse the prisms at once and give a few minutes exercises with base-in prisms in order to restore the faculty of reciprocal innervations, the balance between the antagonistic muscles.

Induction, like all the other ductions, must be looked as representing the flexibility of readjustments. If there is freedom from stress, ductions are high. If there is tension, if there is obstruction to the delivery of the commands of the central nervous system, ductions are low.

HYPERPHORIA: VERTICAL DUCTIONS

THERE is comparatively little true hyperphoria, but in imbalances between convergence and accommodation there appear spurious hyperphorias. These latter will disappear when convergence and accommodative efforts are balanced, when the cause of the strain is removed, either by correcting lenses or Kratometer treatments, or by the two in combination.

Displacement tests for hyperphoria, with horizontal prisms, bases-in or bases-out, are unreliable. For should the patient happen to tilt the head ever so slightly to right or left, this would produce the effect of a right or left hyperphoria, lead to false assumptions. The same is true of the

Maddox double prism. There are also uncertain inhibitory or innervational effects on the oblique muscles in these tests.

A finding of hyperphoria by any of the classic tests must be confirmed by vertical duction tests. Reliable vertical ductions have been unobtainable by any apparatus until the introduction of the Kratometer, with its 0.25 △ units, made them possible.

Accurate measurement of the vertical ductions with loose prisms or with rotary prisms is out of the question. For, because of the powerful innate function that turns both eyes up or down together, the vertical ductions can only be measured by small and careful steps, otherwise the true dissociative ability, which is what we are measuring in these ductions, cannot be justly determined. Such small steps cannot be made with loose prisms nor with rotary prisms. In addition, the effect of rotary prisms is not directly up or down, but oblique, which introduces an unwanted element.

The ocular rotations induced in the Kratometer tests are directly vertical. There is the minimum of association of other muscles than the superior and inferior recti.

Suspension and suppression are so often present in difficulties of the verticals, that we strongly advise the use of the vertical test described under suspension. But if the operator is positively assured that the patient is entirely free from the suspension habit, the following procedure may be followed:

The test may be made at either distance or near. Correcting lenses should be in the rear lens cells. Adjust the pupillary distance of the batteries to conform to the patient's for the distance at which test is to be made. Set the rotary disks at OPEN.

Insert one vertical prism slide at *base-up over the right eye*, the other vertical prism slide at *base-down over the left eye*, with the open cells in the sight openings. Use Chart No. 1 for the distance test, Chart No. 2 for the near test.

Advance the prism power one step at a time, alternating the steps between the eyes, first over the right then over the left. Allow a second or two between each prism jump. You are now testing the right inferior rectus against the left superior rectus. The duction ability is measured by the combined prism power over the two eyes at the last step before diplopia occurs.

Then reverse the vertical prism slides, setting one at *base-down over the right eye* and the other at *base-up over the left eye*. This will measure the right superior rectus against the left inferior rectus. Proceed as before, and compare this finding with that of the first test.

Only these two tests are necessary. First, the measurement of the antagonistic abilities of the right inferior rectus against the left superior rectus; second the antagonism of the right superior rectus against the left inferior rectus. This is the power of possible dissociation of the primary impulse to turn both eyes up or both eyes down.

When the upward ductions of the right superior and left superior recti, or the relaxing ability of the right inferior and left inferior recti, are unequal, there is a tendency to hyperphoria. Or when the downward ductions of the right inferior and left inferior recti, or the relaxing ability of the right superior and the left superior recti, are unequal, there is tendency to hyperphoria. These comparative ductions and relaxations are found by putting in antagonism the right superior rectus and the left inferior rectus, and pitting the left superior rectus against the right inferior rectus.

If the findings by these two tests are equal, there is no vertical imbalance. If, however, the possible ductions are low, say only 2.00△ or 2.50△ is the sum of the powers in both vertical prism slides in both tests, then possible motility and freedom of action is low, and vertical exercises should be given to increase the range of elastic movement.

If there is more than 0.50△ or 0.75△ difference between

the two findings, exercises should be given to increase the range in the direction of the lower duction. For example, if the right inferior against the left superior shows ability to overcome 4.00△ while the power of the right superior against the left inferior is only 3.00△, exercises should be given to build up this lower power to an equality with the first.

It is very rarely possible, if there be a structural defect of any of these vertical muscles, to locate the exact muscle, and such location is not necessary. It is only essential to know the functional ability and the innervational resources at command for overcoming the structural error.

In the event that a vertical diplopia is manifest at once, if the patient at first glance sees two test objects, the proper procedure is detailed in the instructions for the use of Chart No. 4, in the section on "Vertical Ductions in Suspension."

If an hyperphoria is suspected, the vertical ductions must be taken first in the opposite direction to that of the manifest hyperphoria. For example, if we suspect a left hyperphoria, the first duction must be with prism base-up over the left eye, base-down over the right. Or the reverse in suspected right hyperphoria. For in hyperphoria the tonicity impulses are flowing in the direction of the manifest hyperphoria; taking ductions in that direction adds further tonicity in that direction, inhibits the already low tonicity in the opposite direction. Hence, to take the duction in the direction of the manifest hyperphoria as the first step will in itself reduce the duction in the opposite direction, give an incorrect idea of the value of the hyperphoria, make it difficult to distinguish true and false hyperphoria.

The treatment of hyperphoria is detailed in the section on "Exercises for Hyperphoria" (page 86).

HORIZONTAL PHORIA AND DUCTION TESTS IN CASES OF SUSPENSION OR SUPPRESSION

Use Chart No. 3, set at 35 cm. from the eyes. Put reading correction in rear lens cells. Adjust the pupillary distance

of the batteries in exact agreement with the patient's reading pupillary distance. Draw forward the stereo septum, turn-

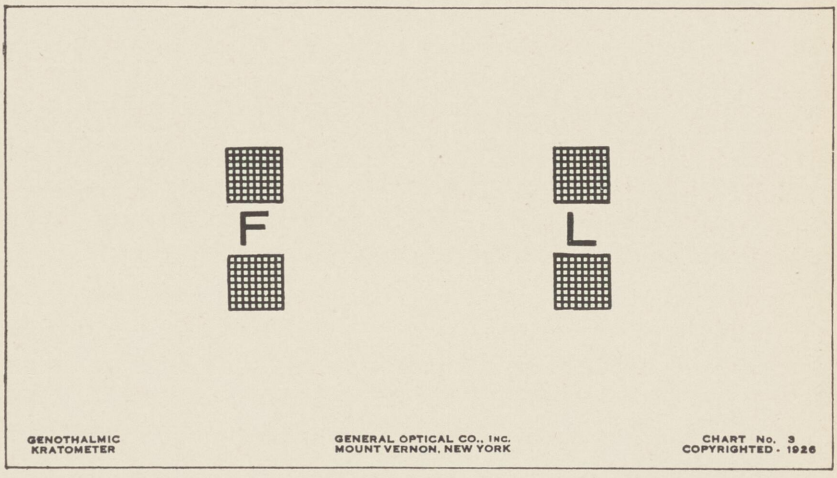


Chart No. 3

ing flat side toward the patient. The correct position for this is from 15 to 20 cm. from the patient's eyes. The wider the P.D., the farther out is set the Septum.

On Chart No. 3 are the letters F and L. The Septum is to be adjusted so that the F is seen only by the left eye and the L is only visible to the right eye. Fused, the F and L combine to make the letter E.

The checkered squares on this card are often useful in checking the astigmatic corrections. See the section on torsions and oblique astigmatism (Page 93).

Set the rotary disks at OPEN. Insert the horizontal prism slides in their brackets with 10△ base *out* before each eye, a total of 20△.

If the patient now sees the letter E, balance and good muscular tonicity are indicated. If he sees the letters as L-F, it shows low tonicity. If he reads F-L, hyper-tonicity is indicated. (See next section, on "Tonicity Test at the Near Point.")

If he sees only F, the right eye has suspended. If he sees only L, the left eye has suspended. In either event, cover the seeing eye (hold a card or the hand over the sight opening for a second) and the suspended eye will resume vision. Then remove the cover and inquire if both letters appear. Sometimes considerable patience is required before both letters are seen at the same time.

There are cases where the alternation of vision is total, the two eyes never functioning at the same time. In that event, the patient will see F, then L, then F, etc., but never F - L or E.

If the occasional lapse of vision by one eye is due to suppression because of some stress, as latent hyperopia or a true hyperphoria, the cause must be removed. Study of the latent hyperopia and latent exophoria and of the vertical ductions will reveal this.

If the occasional lapse of one eye, or the alternation of vision, is due to the habit of suspension, Kratometer exercises must be given to develop the habit of attention. Both the habits of occasional suspension and of complete alternation can be eradicated by Kratometer treatments. No other instrument has yet appeared of which this can be truthfully said.

If the patient does not at first see E, but sees F - L, increase the prism strength until he sees E. If he sees L - F, decrease the prism power until the E is obtained. At every step make sure that neither letter disappears.

Warn the patient, when making the phoria or duction tests with this card, to speak instantly if either letter disappears, and do not proceed with further prism changes until the E is seen. Very often, in taking the ductions, and in giving exercises, when one of the eyes suspends, it is necessary to take several backward steps with the prism slides before the E can be re-fused.

In the very rare cases of total intermittency, where both

eyes never see at the same time, no ductions can be made, for there is no knowledge of fusion.

If either letter should appear higher than the other, prisms from the trial case may be inserted in the front lens cells to bring the two letters to the same height. This is very liable to occur in toxic diseases that have affected nervous conduction, and must not be taken as evidence of true hyperphoria.

In these cases, suppressions are very common. The central nervous system prefers to ignore one image, rather than make the supreme effort involved in maintaining both images on both maculae.

The same cause for suppression and the same effects are often noticeable in esophoria, in true and false hyperphoria, in true and false cyclophoria. In all these cases, the phorias and ductions can only be determined by Kratometer methods.

As before stated, balance is indicated when the patient sees the letter E with 10△ base-out before each eye, when the test chart No. 3 is 35 cm. from the eyes. In cases of suspension or suppression, it will sometimes require quite a bit of patience before the patient sees both letters simultaneously. If some base-down or base-up prism is required to help him get simultaneous vision with both eyes use it. In cases of very poor vision in one eye, where either the F or the L cannot be seen, use the methods described under Amblyopia.

In cases of hyper-tonicity, the amount is measured by the amount of additional prism (above the normal 20△) required to fuse the two letters into E. (Pages 53–54.)

For example, if 12△ is required over each eye for fusion, a total of 24△, the tonicity excess is 24△ — 20△ = 4△.

In making this measurement, increase the power of the prism slides (which were first set at 10△ base-out over each eye). If more than the 13△ of each slide is required, turn in additional 3△ or 5△ base-out from the rotary disks.

In cases of low tonicity, the deficiency is measured by the amount of reduction necessary from the normal 20△. If the

slides must be reduced to 6 △ over each eye, the tonicity deficiency is 20△ — 12△ = 8△. (Pages 53-55.)

Always commence this test with 10△ *base-out* in prism slides before each eye, which is the normal prism power with the card at 35 cm. To start with any other strength will lead to misleading conclusions.

In pronounced cases of suspension, have the patient name, after each change of 1△ prism, the letter or letters he sees. This not only advises the operator as to the degree of intermittency and warns against further prism change until both eyes see and fuse, but teaches the patient the necessity for constant attention. It is lack of attention in the secondary visual centers (in the cortex of the brain) that is the cause of intermittency of vision, or suspensions. Kratometer treatments attract the unremitted attention of secondary visual centers of both eyes, create the desired habit of continual attention.

After finding the prism power that will fuse the F and L into E, take the induction and abduction reserves.

Abduction is taken by decreasing the base-out prism power. When the E breaks into F - L, and cannot be re-fused, the limit of abduction, or convergence relaxation, has been passed.

It is possible for a good relaxation ability to hold the E down to the zero openings, and even to overcome as much as 3△ or 5△ base-in from each rotary disk.

Induction reserve is taken by increasing the prism base-out. When the E breaks into L - F, the induction reserve power has been passed.

It is a very poor showing when at least 5△ base-out from both rotary disks in addition to the full power of the prism slides is not readily overcome.

If the start is at 10△ base out over each eye, and the break into L - F occurs after passing 23△ base-out over each eye (10△ from each rotary disk and 13△ from each

prism slide) which is a total of 46△, the induction reserve for the reading distance is 46△ − 20△ = 26△. If this same person is able to relax the convergence down to the zero openings and up to 6△ base-in (3△ base-in over each eye) before the E breaks into F - L, the convergence relaxation at the reading distance is 20△ +6△ = 26△.

If the initial fusion point is at 16△ base-out (8△ over each eye) and the induction is carried to 24△ (12△ base-out over each eye) before the break occurs, the reserve induction at the reading distance is 24△ − 16△ = 8△. With this same starting point of 16△, if the abduction is carried to 2△ base-out (1△ to each eye) the convergence relaxation at the reading distance is 16△ − 2△ = 14△.

Always, the induction reserve is the difference between the amount of base-out which originally fuses the E and the amount that can be held before the E breaks into L - F. And the convergence relaxation is the difference between the initial fusing amount and the power that is held just before the E breaks into F - L.

As stated previously (see Induction Tests), speed and ease of adjustment are more essential than the amount of prism overcome. In the suspension cases, to the three items of amount, speed and freedom from fatigue must be added the ability to maintain unintercepted binocular vision.

Regular exercises with a single test object cannot be instituted until the habit of suspension has been completely eradicated.

Suspension frequently accompanies myopia. In troublesome exophoria and convergence insufficiency, suspension is almost always present. About 10% of all the cases that come to the refractionist are afflicted with suspension.

More than half the cases needing innervational exercises are troubled to a greater or less extent by suppression or suspension. The first exercises are to be devoted to the eradica-

tion of this habit, it is useless to proceed in other directions until this has been accomplished.

The Genothalmic Kratometer is the first instrument to be specifically designed for the treatment of the suspension habit.

THE TONICITY TEST AT 35 CM.

In the following test, the convergence-accommodation effort is divorced from the muscular tonicity function, the latter is permitted to show its true status. For in the dynamic phoria test at the near point, the visual reflex dominates, a low exophoria is often shown when there is truly a subnormal tonicity of considerable degree. The refractionist, therefore, is at a loss to account for the complaints of the patient as to fatigue when doing close work or reading since in the ordinary tests no cause for that fatigue is shown.

Adjust the Kratometer as described for the Horizontal Phoria Tests in Cases of Suspension or Suppression (pages 47-48), with 10△ base-out over each eye, the septum in place, Chart No. 3 at 35 cm.

If tonicity is steady, the patient at once sees the letter E. To fail to make E with 10△ base-out over each eye indicates departure from normal tonicity and lack of nervous control. While this test is directed at the tonicity of the extrinsic ocular muscles it is usually symptomatic of the general body tonicity.

If the patient reads L - F, exhaustion and low tonicity are indicated. This may be due to the lack of sufficient plus lens power for near work or it may be due to lack of exercise, bodily or mental exhaustion, or to illness.

If the patient reads F - L this is a condition of hypertonicity. Excepting in some cases of slight esotropia where suppression is not rigidly enforced, it may be considered as a

dangerous symptom, the patient should be referred to a competent neurologist.

The method of measuring the amount of hypertonicity (by base-out prisms) or of subnormal tonicity (by base-in prisms) with the F - L card has been described in the previous section. (Page 50.)

Fortunately, hypertonicity is not frequently encountered. But cases of subnormal tonicity are very common. Before embarking on a course of treatment, the cause must be definitely analyzed.

If the low tonicity has been brought on by the exertion of carrying a load of latent hyperopia, base-in exercises to break loose the control of convergence over accommodation should be given, that the hyperopia may be made manifest, made correctible, that the full plus correction may be worn without blurred vision.

If the low tonicity found in this ocular test is but a symptom of general bodily fatigue, then base-out exercises are quite in order. These will build up general body tonicity to a certain extent, as well as developing tonicity in the ocular muscles. The patient should also be advised to take plenty of outdoor exercise and should watch the diet and the intestinal action.

If the low tonicity is of afferent origin, indicative of disinclination to make an effort to get sharp vision, with a consequent poor afferent stimulus and poor efferent response, exercises directed to stimulating concentrated attention will prove helpful. These are given with base-out prisms. Also use the exercises for general motility. (Pages 27, 75, 125.)

Very often adults who have not fully developed the function of convergence-accommodation make a poor showing with the F - L test. Give base-out exercises to develop this function. Equally, wearing weak base-out prisms will help materially. (Pages 74, 80, 110, 125, 130.)

Among the tests for convergence insufficiency the "F - L"

Chart used with the Genothalmic Kratometer is the most sure and definite. Even if there is no suspension, this test should be made as a routine part of every examination.

Ordinary phoria and duction tests tell nothing of the functional sufficiency or insufficiency of convergence. But the truth is immediately revealed by the patient's success or failure in forming the letter E with the normal 20△ base out in the Kratometer.

Do not confuse the various types of convergence insufficiencies. Do not confuse the arrested development of convergence-accommodation with the exophoria of low bodily tonicity. Above all, do not confuse this with the insufficiency of exhaustion often found accompanying esophoria and latent hyperopia, and due to the terrible drain on the nervous system in furnishing compensating accommodation to overcome the hyperopic error. In this type, give relaxation exercises, with *base-in* prisms, and uncover and correct the latent error by the cross-cylinder methods described in another section.

VERTICAL DUCTION TESTS IN SUSPENSION OR SUPPRESSION

Use Chart No. 4, set at 35 cm. Reading correction is placed in rear lens cells. Adjust the instrument as in the F - L test, but in place of using the horizontal prism slides, set both rotary disks at 10△ *base-out*. Insert the vertical prism slides in the brackets as already described under Vertical Ductions. (Page 44.)

If the F - L were not fused into E by the normal 20△, make up the deficiency by using loose prisms from the trial case, such prisms being placed in the front lens cells. If the patient reads F - L, these compensating prisms are placed base-out. If he reads L - F, the compensating prisms are placed base-in. If the deficiency happens to amount to 10△, the rotary disks can be changed in agreement. Divide the compensation equally between the two eyes.

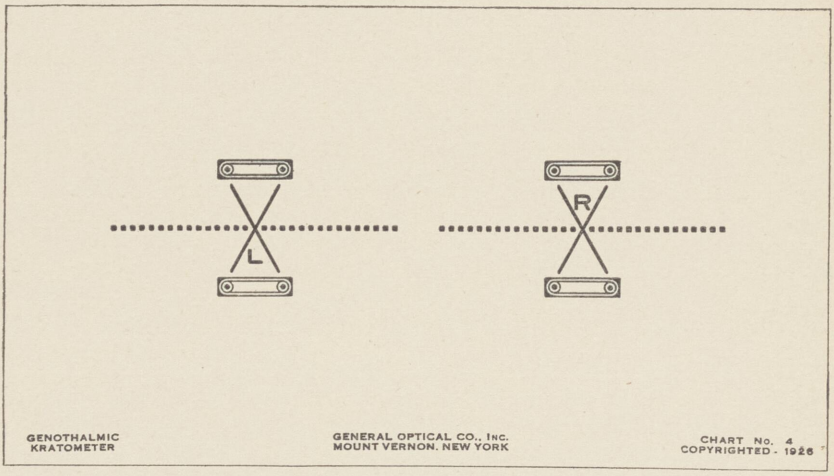


Chart No. 4

The patient should now be able to fuse the two X's and the ornaments and see one line of dots. The letters R and L are tell-tales against suspension of right or left eye.

The procedure is now exactly the same as in taking vertical ductions with a single target, but warn the patient to speak instantly if either the R or L disappears. In this event, cover and uncover the seeing eye rapidly until the suspending eye resumes vision and fusion. In bad cases of suspension, proceed deliberately, pausing for two or three seconds between each prism jump.

In using Chart No. 4 for the vertical ductions, the aim is to find how many quarter diopter steps can be made before the row of dots breaks into two rows. The ornamental oblongs serve as guides, or controls, to the extra-macular version fields. The X's serve as guides to fusion and as indicators of convergence tonicity.

If at the beginning of the test, with no vertical prisms before the sight openings, the patient sees two rows of dots, insert in the front lens cells loose prism from the trial case of sufficient power to make one row of dots.

If such compensating vertical prism is used, its power is to be added to the duction that is found in the direction in which the apex of this prism is pointed.

For example, suppose 2△ base-up is needed over the right eye, its apex is pointing down to the right inferior rectus. Therefore it is already forcing a duction of 2△ to the right inferior rectus. Then, proceeding with the ductions, with this 2△ in place, and with the vertical prism slides at *base-up* over the *right* eye and *base-down* over the *left* eye, we find we can use 3.50△ more before the antagonism of the right inferior rectus against the left superior is overcome. Therefore, the duction of the right inferior rectus against the left superior rectus is 2△ + 3.50△ = 5.50△.

Then, if we find that the limit of the antagonism of the left inferior rectus against the right superior rectus is 1.50△, the deficiency of these antagonists amounts to 5.50△ − 1.50△ = 4△.

The half of this deficiency, or 2△, is the measurement of the right hypophoria or the left hyperphoria, whichever we denominate the imbalance.

If we practise the old rule of "Prism in the Position of Rest," we should give this 2△ as base-up to the right or base-down to the left or divided equally between the two eyes. But Kratometer practice is to give such treatment that the ductions are equalized, and the hyperphoria becomes non-existent, as further discussed under the "Treatment of Hyperphoria." (Page 86.)

While taking the vertical ductions with Chart No. 4, investigate at the same time the tendency to cyclophoria. When the two rows of dots appear, ask the patient if they are parallel or if one is oblique. In the latter event, cyclophoric tendencies are present. See the section on "Torsions and Cyclophoria." (Page 93.)

EXERCISES FOR SUSPENSION AND SUPPRESSION

USE at first Charts 5, 6 and 7. When these pictures can be successfully used without loss of either image and the ductions have been built up to a fair amount, add the stereoscopic charts 8, 9 and 10 to the group of daily exercises.

In Chart No. 5, the child is common to both eyes. The gnome at the right with pointing finger is seen by the nasal side of the right retina. The gnome at the left with the broom is seen by the nasal side of the left retina. With the two images of the child fused, gnome with broom is on the left and gnome with pointing finger is at the right.

In Chart No. 6, the tree is common to both eyes. The hornets' nest is seen by the temporal side of the left eye. The boy is seen by the temporal side of the right eye. In the stereoscope, with the trees fused, the boy will be on the left side of the tree and the nest is at the right.

In Chart No. 7, the pirate's face and hat are common to both eyes. The patch on the hat is slightly smaller than the diameter of the macular field at 35 cm. The skull is seen by the right macula, the crossbones is seen by the left macula, if the attention is fixed on skull and crossbones as it should be while exercising with this card.

Suspension may occur in any one of these various fields, without the other fields being affected or losing vision. This set of three cards is designed to offer a series of exercises that will command the constant attention of each of these visual fields in turn, and to give proper attentive education to these fields.

If the patient, at any time, remarks that part of one of the figures is disappearing, a white space moving up in place of the figure, we may justly suspect scotoma. If one of the figures moves out of its proportionate distance to the other figures in the picture, doubtless suspension in one of the fields has occurred. For example, in Chart No. 6, the nest

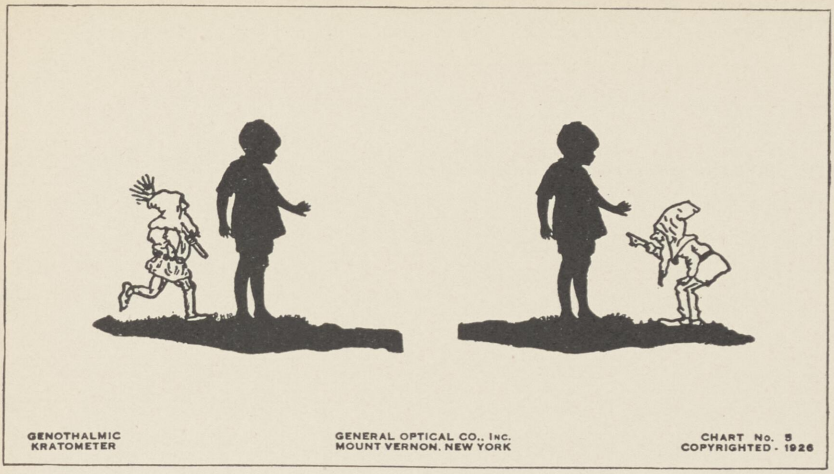


Chart No. 5

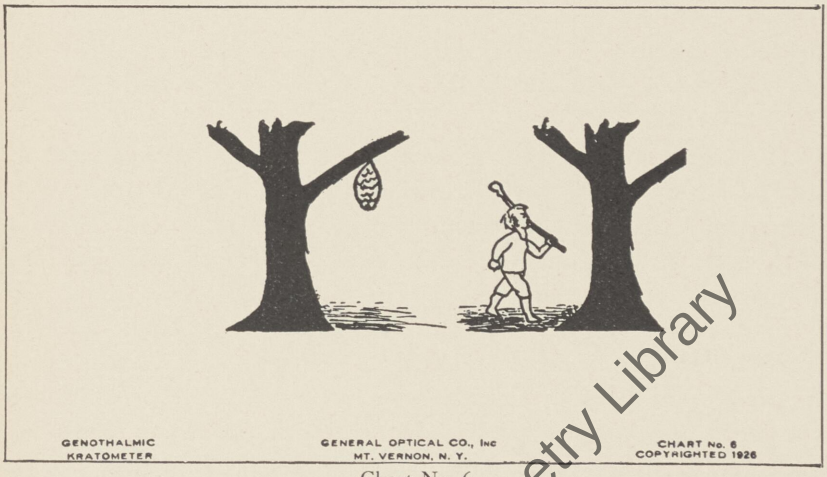


Chart No. 6

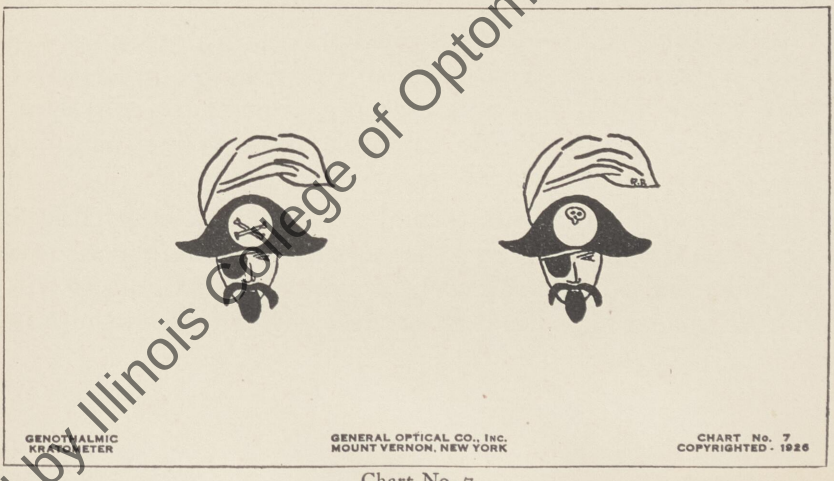


Chart No. 7

might move out to the end of the limb, or in Chart No. 5, one of the gnomes might seem to walk up to the child, even go behind him. Then, surely, the function of fusion is suspended.

Set the card at 35 cm., with the stereo septum drawn forward to its proper position. Make the proper combination of prism base-out from rotary disks and horizontal slides to accomplish fusion, as found in the phoria test with the F - L card. Have equal amount of prism over each eye.

If the F - L fuses into E with 10△ base-out over each eye, adjust the rotary disks to 5△ over each eye and the horizontal slides to 5△ over each eye. This will give the total required, and the slides are in position to be moved in both directions.

If more than 10△ over each eye is needed to fuse the E, use as much power from the prism slides and as little from the rotary disks as possible. If no more than the 13△ of each slide is required, set the rotary disks at zero and the slides at 13△. If more than this is needed for fusion, use 3△ base-out from the rotary disks and make up the balance from the horizontal slides. As this is a condition of hyper-tonicity of the inturning muscles, no induction exercises are to be given. Work entirely on development of convergence relaxation, by reducing, step by step, the power in the horizontal slides.

If less than 10△ over each eye forms the E, set the rotary disks at zero and the horizontal slides at the required power. Exercise the induction by increasing steps of the horizontal slides. As induction reserves increase, more power, base-out, can be introduced from the rotary disks.

If more or less than the normal 10△ to each eye is required for fusion, let the exercises be devoted to building up that innervational condition that will enable the patient to fuse the two images of any and all of these charts with this normal

10△ base-out to each eye when he first looks through the sight openings. After this primary desideratum is attained, and any habit of suspension or suppression is eradicated, the attention can be turned to increasing speed and freedom from fatigue, using Chart No. 11, as described in later sections.

If, at the beginning, the pictures are fused with the normal 10△ base-out to each eye, exercise both the induction and the abduction, until all danger of suspension is surely eliminated. Vertical exercises are also to be given daily, using the same cards, Nos. 5 to 10, inclusive.

Suspension is due to an inattentive habit. It is quite common among those who have not developed the convergence-accommodation to its full possibilities. Convergence-accommodation as a function is itself an attention reflex, aroused by interest in the object of regard. Kratometer exercises with base-out prisms are the most efficient method of enforcing concentrated attention. When this is aroused, the habit of suspension will cease.

Suppression is the ignoring of one image when the stress of maintaining simultaneous binocular fixation is too great. It is the central nervous system's method of avoiding stress. Latent hyperopia is a frequent cause of suppression. The refractionist must be precise in his analysis of the case, that he may avoid mistaking suppression for suspension. Suppression is only to be mastered by removing the cause of stress.

But suppression can develop into the habit of suspension. In such event it is not only necessary to remove the primary cause of stress but to re-educate the habit of continued attention by proper Kratometer treatments.

In giving exercises with these charts, make no attempt for speed in the early stages of the work. Especially, if the patient advises that the objects individual to each eye seem to jump about or move out of their proper position with respect to the main part of the picture which is seen by both eyes, one

must give plenty of time for readjustment between prism jumps. It is often advisable to first give the exercises described in the next section, giving little heed to the matter of fusion at first, but directing the effort toward sureness of continued attention. Then we may return to the use of these charts with assurance of ultimate success in eliminating the suspension habit.

EXERCISES TO CORRECT ALTERNATING FIXATION

WHEN intermittency is total, that is, when the visual fields in the brain give attention to but one eye's image at a time, alternate between the two eyes, never interpret simultaneously the sensations from the two eyes, we have a condition that until very recently was thought absolutely incurable.

But several students of Kratometry, enthusiastic over its wonderful and untold possibilities, have learned that what has always been regarded as impossible is possible, have found the method is simple in the extreme.

First, correct any manifest refractive error if such correction will improve sharpness of vision. Provide yourself with a collection of attractive, highly colored pictures in which RED predominates. Magazine covers are excellent for this work. These pictures are hung on the wall or on an easel in front of the patient, five to ten feet away, must be brightly illuminated.

Adjust the Kratometer in position, with the lens corrections, if any, in the rear cells. Adjust the rotary disks to OPEN. Set both prism slides at ZERO, with the prism apices pointed *in the same direction over both eyes*. That is, when using the horizontal prism slides use base-out over the right eye and base-in over the left eye, or, vice versa, base-out over the left eye and base-in over the right eye; when using the vertical prism slides use base-up over both eyes or base-down over both eyes.

Push the slides up and down rapidly, simultaneously bebefore both eyes. Do not stop at each change in prism power, with each click of the pawls, but move the slides up and down as rapidly as possible without pause.

The jumping brilliant picture will attract attention from both hemispheres of the brain. After a time, this simultaneous bilateral irritation will develop to persistent simultaneous attention. Generally there follows a period of diplopia, the patient will "see double." Now is the time to lengthen the exercise periods, using this same method throughout, paying no direct attention to the subject of "fusion." In a few days the stresses, or obstructions to versions, will be removed, the two foveas will swing beneath the two images, single binocular vision will obtain.

It seems incredible that so simple a technic should produce such invaluable benefits. But true it is, astounding as it may seem. Since the Kratometer principle is based on known physiological factors, is not a theory developed to support some speculative hypothesis, the Kratometer is the only instrument yet devised that will care for this defect which was until now thought ineradicable.

Give about five minutes' exercise with the horizontal slides, both prisms pointed to the left, then five minutes with both prisms pointed to the right; then use the vertical slides, five minutes with both prisms pointed up, then five minutes with both prisms pointed down. The patient will not be fatigued.

Change pictures often to avoid loss of interest. Remember, the sole purpose is to arouse interest and concentrated attention. Have the patient count the number of items he can see in the picture. Vary the exercises with pictures by placing a sheet of printed matter in the chart holder and have the patient spell the words *backward* while the prism slides are being run up and down before his eyes.

Do not become discouraged if several weeks, or several months, elapse before you can notice any effect from the ex-

ercises. Do not allow the patient to become disheartened. Assure him that persistence will win. Warn him at the outset that a period of diplopia will probably occur, so that he will not be frightened when it does come.

As noted in the preceding section, this is an excellent exercise to use when there is trouble experienced with Charts Nos. 3, 4, 5, 6, 7.

After persistent binocular attention has been secured, turn to Charts 5, 6, 7 for the development of motility without suspension or suppression. Then use Charts 8, 9, 10 for the further cultivation of stereopsis.

Use this same technic in correction of alternating strabismus.

STEREOSCOPIC VISION

USE Chart No. 8. Positions of chart, septum, pupillary distance, prism slides, etc., are the same as with the F - L card.

When fused, these two drawings will present a picture of a deep box, if there be the sense of stereopsis. If this sense is absent, the picture will appear merely as a flat drawing. As prisms are slid up and down before the eyes to the person

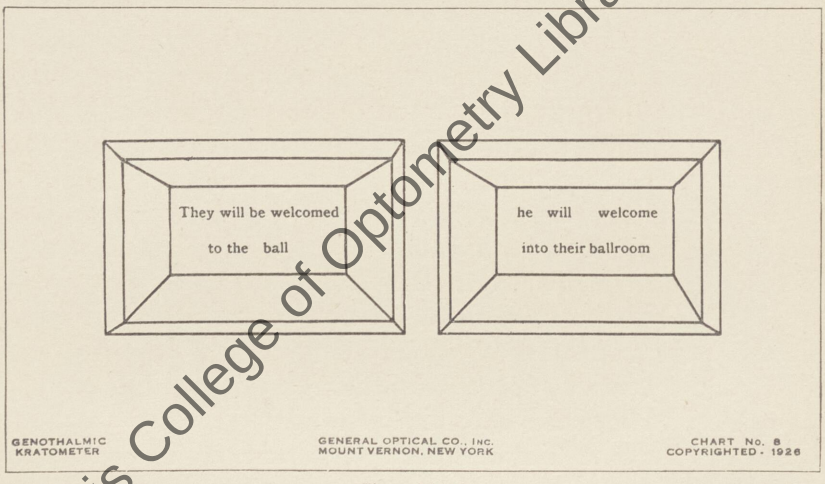


Chart No. 8

with stereoscopic sense the box will apparently grow deep or shallow, depending on the direction in which the prisms move.

The sentences printed on this chart are for the purpose of warning against suspension.

For exercises to develop the stereoscopic sense, use Charts 8, 9 and 10. To these may be added the use of stereo geometric figures, which are for sale by many jobbers, and the usual stereo-photographs which may be had from the various photographic concerns specializing in their production.

Stereoscopic sense enables us to judge of depth, distance and relief. Persons devoid of this sense seldom prove safe motor drivers. Stereopsis develops rapidly under Kratometer treatments, more rapidly than with any methods yet proposed.

Exercises in motility should also be given, developing the powers of quick adjustment. (Page 82.)

A course of stereoscopic exercising should be made a part of the routine of all exercising, including those for increasing

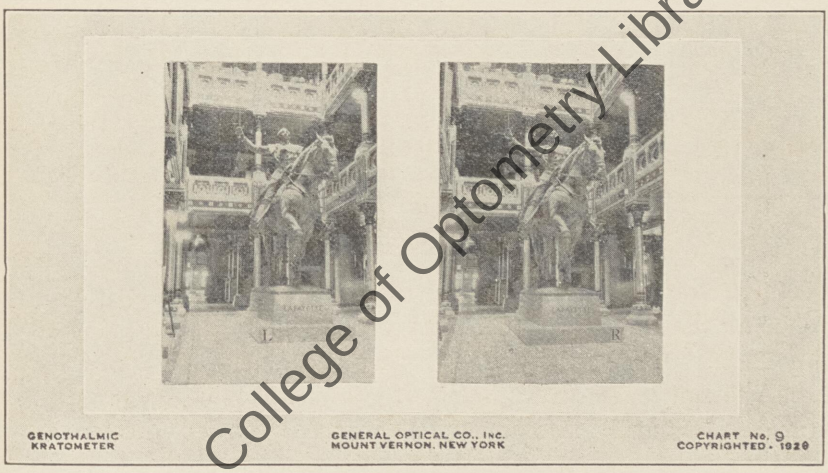


Chart No. 9

reserve induction, accommodation and convergence amplitudes, convergence relaxation, etc.

On Chart No. 9, the letters R and L are used as warnings against suspension of one eye or the other. Any other stereoscopic pictures used in exercising should be similarly marked.

In Chart No. 10, to the person without stereoscopic sense, the arrows of the windvane will fuse but will seem to lie flat against the card. But to the one blessed with stereopsis, the arrows will stand at angles to each other, and as the prism slides are run up and down before the eyes the arrows will seem to swing back and forth. Note the slight differences in the two pictures as guards against suspension.

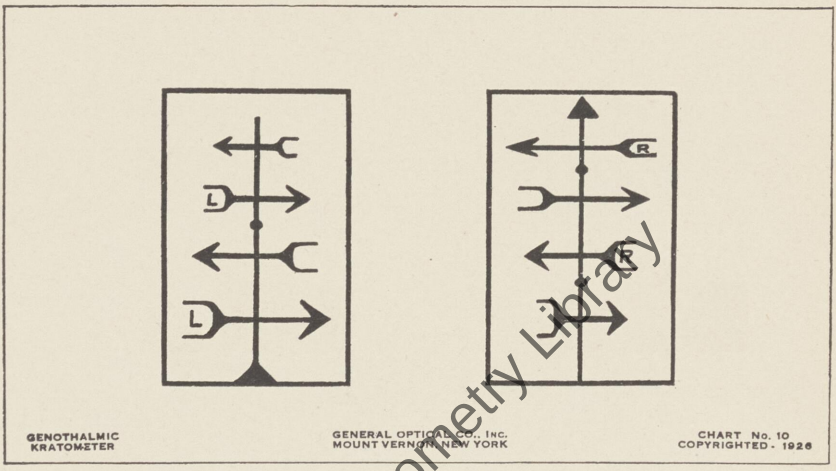


Chart No. 10

Daily exercises with these three charts should be given to every patient. These develop fusional habit, swift motility, sense of distance and speed. If stereopsis is lacking, it can be developed more rapidly and more surely with Kratometer exercises than by any method yet made known. When these stereoscopic exercises are used in addition to the routine duction exercises with a single target, the patient will develop the desired functional abilities of binocularity very rapidly.

Stereoscopic vision is the result of swift mental comparison of two dissimilar pictures. It is the binocular perspective derived from the comparison of overlapping monocular perspectives. Most people can "see stereoscopically" when geometric objects are presented, or when the object or the person himself is still, with sufficient time for adjustment, fixation and perception. But in swift motion of objects or eyes, there are some people of such slow perception and responsiveness that stereopsis is lost.

Of course, stereoscopic vision is out of the question in cases of suspension or suppression. Some people do not suppress or suspend vision of one eye while quiet, as in reading, but do suppress while viewing moving objects. Some suppress or suspend only in moments of excitement or hysteria.

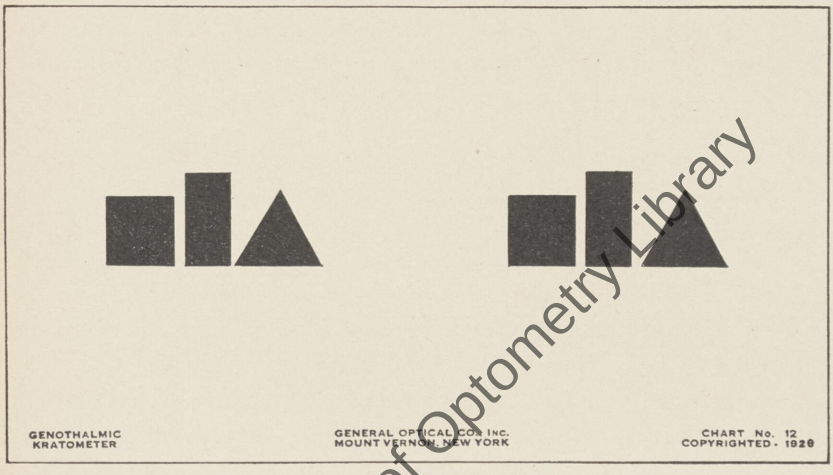


Chart No. 12

Chart No. 12 may be used as a test for stereopsis with the speed factor eliminated. When viewed through the Kratometer with the stereoscopic adjustments in place, the middle figure will seem to stand out in relief, farther forward than the two side figures, and the three figures will appear in

different planes. This chart may be used as a preliminary test of stereoscopic knowledge, while Charts Nos. 8 and 10 will be used with the horizontal prism slides being pushed rapidly up and down to learn if speed of perception and responsiveness of muscle action are sufficient for stereopsis of moving objects. Chart No. 12 is also to be used in exercises when the faculty of stereopsis is found wanting.

The old tradition that stereoscopic vision cannot be trained if it is not developed within the first few years of one's life is found without foundation now that the Kratometer has made possible the development of vision in highly amblyopic eyes that did not respond to the less direct and less forcible methods previously employed. For we find that when we train the faculties of attention, quick perception, immediate muscular reflexes, that stereoscopic vision can be developed therewith. (See pages 155-156.)

TEST FOR EQUAL SIZED IMAGES AND EQUALITY OF VISION

WHILE equality of vision in the two eyes or equally sized images are not a prerequisite to stereoscopic vision, equally sized images and equally sharp images are to some people essential to comfortable binocular vision.

Use Chart No. 8. Set the stereo-septum in place, hiding the right picture from the left eye, hiding the left picture from the right eye.

Do not use the 10△ base-out prisms, but set the rotary disks at OPEN. The patient can now quickly compare vision of right and left eyes without closing either. This is much better than alternately occluding the eyes and asking if vision is better with the one than with the other. For here we have instant comparison, nothing is left to memory.

Some high exophores can fuse the two pictures without the aid of base-out prisms. If the patient should happen to fuse the two with the rotary disks at the open position, turn both

disks to 5 △ base-in, when fusion will be impossible.

If the words on one side seem unequal in size or clearness to the words on the other side, we have warning of one of two things: Either one or both lens corrections is wrong or one eye is slightly amblyopic.

If changing lens power does not rectify the fault, the eye with poorer vision can be brought up to normal by giving the exercises for amblyopia as set forth in page 95, provided the amblyopia is not of toxic origin.

Remember that it is never permissible to leave the better vision in the eye of the non-dominant side, if it can be avoided. That is, to the right handed child do not permit the right eye's vision to be less than that of the left eye, nor should the left handed child have poorer vision by the left eye than by the right eye. The good eye is not to be fogged, in such cases, but the poor eye is to be brought to dominancy in accord with the dominancy indicated by right or left handedness. Give treatments for amblyopia until vision in that eye is brought to a shade better than in the eye of the non-dominant side.

Much distress in later years can be avoided if children are thus cared for. While in adults, discomfort can be changed to comfort by such attention.

EXERCISES FOR INCREASING CONVERGENCE RELAXATION

INCREASING the amount and the speed of binocular abduction in cases of esophoria will free the patient from headache. Exercises are given with base-in prisms, for prisms in this position inhibit the innervation of convergence.

Furthermore, as these exercises proceed, they tend to break down the synergistically equal innervation of accommodation and convergence, which in this type of cases is undesirable. Following this, the latent hyperopia becomes manifest and can be corrected.

These same exercises are to be given in cases of accommodative, or pseudo, myopia, with the same purpose in view, the separation of the allied convergence and accommodation that has brought on the myopia. In these cases, the purpose is to build up convergence relaxation so that base-in prisms can be prescribed for constant wear in lieu of minus lenses; in other words, to return the eyes to their normal condition of emmetropia or low hyperopia with little convergence needed, the convergence requirement being offset by the base-in prisms.

In all cases of progressive myopia, give exercises to increase convergence relaxation, and prescribe prisms, base-in.

In those cases of exhaustion resulting from the habitual covering of latent hyperopia and latent exophoria, give relaxation exercises, for these will break up the too closely knit association of convergence and accommodation, and make possible the prescription of the needed full plus correction.

Convergence relaxation exercises should be given at both distance and near. At the distance, use Chart No. 1, or a large letter or picture as fixation target. For the near point exercises use stereo-charts, such as Charts 5 to 9, as well as exercises with a single target such as Chart 11, or any similar small picture.

Give convergence relaxation exercises with the full correction in the rear lens cells. Often, placing +0.50 D. or +0.75 D. spheres in the front cells will prove helpful. In presbyopia, the presbyopic addition must be placed in the rear cells while exercising at the reading distance.

Suspension is seldom found with accommodative esophoria, but is frequently met in myopia. In cases of suspension, use Charts 3, 5, 6 and 7, as directed under "Exercises for Suspension and Suppression." (Page 58.)

Suppression is frequently met in esophoria, and can be treated with the methods already described.

Since the purpose of these exercises is to educate in the convergence centers *the habit of relaxation*, and the formation of any habit depends on the frequency of repetition of the act, we need to make as many successive prism jumps as possible. Since repression of the accommodation will assist in increasing the convergence relaxation, we should give these exercises with a little more plus added to the distance correction. This extra plus is placed in the front cells, so that these supplemental lenses may be inserted or withdrawn at will, without loss of time or disturbance to the patient.

If the convergence relaxation is only 3△ or 4△, begin exercises with rotary disks and prism slides in position as at the beginning of the abduction test, 5△ *base-in* from both disks, 5△ *base-out* from both slides. Reduce the power of the prism slides, moving the slides alternately, 1△ at a step. Go within 1△ of the breaking point, but try to avoid causing diplopia. Then reverse the slide movements, increasing the power base-out and working up considerably past the zero point until some 5△ or 6△ base-out is before each eye. Then start in the reduction once more and work down to the same point as formerly. Repeat this up and down movement ten or twelve times. Rest a minute and repeat. At the beginning, allow a second or so between each jump of the slides. As you approach the breaking point, it is well to allow even more than this, allowing time for recovery between prism changes.

After a time, make an effort to increase, by 1△ or 2△, the amount of prism that can be overcome. Tell the patient to make an effort to bring the images together into one, in case diplopia occurs. As the lessons proceed, he will more successfully re-fuse the broken image.

As a variant, give exercises at the reading point with the stereo-septum in place, using Charts Nos. 5, 6, 7 and any others of similar type that may be at hand. Description of

these exercises is detailed in the sections devoted to suspension.

As described fully in the section on the abduction test, watch constantly for possible suppression or suspension.

Also, give exercises with the vertical prism slides as described under "Vertical Exercises." (Page 85.)

Never omit the "Exercises in Motility and Speed of Adjustment" as outlined in that section. (Page 82.)

Occasionally, a case will be found with no reserve abduction. Exercises will then have to be commenced with considerable prism power base-out from the horizontal slides, anywhere from 5△ to 10△ before each eye, and the power reduced, step by step, to zero. At the beginning, it may be impossible to reduce even to zero power. Perseverance will break through this habit of inhibition to the external recti, and after a time they will be given the required innervational impulses, so that an abduction ability will be built up.

At the beginning, the base-in increases of power should not be made too rapidly. Allow a second or more between jumps. But the decreases in power can be made as fast as one wishes, with a scarcely perceptible pause between the jumps.

Low induction, due to the hyper-tonicity of the convergence muscles, either in cases of latent hyperopia or in cases of esophoria without latent hyperopia, will be increased by giving Kratometer exercises with *base-in* prisms. This will break down the tension, divert the stream of excessive tonicity impulses, relieve the stress. Thus good ductions, with flexibility and facility of adjustments, will be created.

It is not advisable to let the mind of the patient realize that two images can be seen by the simple means of ceasing the effort to see singly. Keep before the patient the idea that he must see ONE image. Do not increase the power to the breaking point.

As soon as the patient becomes accustomed to the pulling

outward effect of the base-in prism increases, begin to move the slides more rapidly. In the lower steps you can soon work up to quite a rapid gait, but as the power increases, allow slightly longer pauses between each jump. Occasionally, make a trial of one extra step over one eye only, to see if you can force a little more relaxation without diplopia. If this succeeds, include this extra step in every turn, and as soon as possible try to get in another extra diopter.

It is seldom that much increase in speed or amount can be accomplished during the first few days. But on each day try to work a little faster and go a little higher.

In exercises for esophoria and accommodative, or pseudo, myopia, remember that the aim is to awaken innervation of the external recti, with corresponding inhibition of convergence.

The purpose of the exercises is attained in both true and accommodative esophoria when the convergence relaxation and dissociation from accommodation has reached the point where the full plus correction is accepted without blurred vision, when the abduction is at least four times greater in prism units than the amount of any esophoria still manifest, and when the accommodation accepts sufficient repressive plus lens power to make a showing of accommodative orthophoria, or at least, a very great reduction of accommodative esophoria, at distance. And in myopia we have accomplished the desired result when a notable reduction of minus lenses (either with or without base-in prism), or the substitution of plus for minus (with or without base-in prism) is accepted for distance vision.

EXERCISES FOR IMPROVING THE TONICITY OF THE CONVERGENCE MUSCLES

ADJUST pupillary distance of batteries for 4 to 6 mm. less than the patient's P. D. Set prism slides in brackets with prisms *base-out*.

The object of these exercises is to build up muscle tone in cases of high exophoria due to low tonicity. But differentiation must be made between the near point exophoria due to exhaustion from the continued efforts of covering an hyperopic error and the exophoria due to general bodily fatigue or mental indifference.

The refractionist must first determine whether there is a latent hyperopia. If there is, exercises are to be given with base-in prisms and the full plus correction supplied. The exophoria will then decrease and the induction will increase. Exercises with base-out prisms should be avoided in these cases. While tonicity may be built up, with a temporary decrease of the exophoria, the results will not be permanent.

High exophoria at both distance and near may be due to bodily fatigue, as in elderly persons who are worn out from over work, or in elderly persons who do not take sufficient active out-of-door exercise and add to their troubles by improper diet, or in the low tonicity that follows a severe illness. In these cases, exercises with base-out prisms will prove beneficial.

In such cases, there is usually a poor circulation of the blood. Debris has accumulated, not only in the muscle cells but also in the nerve cells. Not only is muscle response impeded, but nerve conductivity is reduced. Exercises increase blood circulation; the debris is carried off; new chemicals for tissue repair are carried in; because of the flow of tonicity and adrenaline, chemical balance is restored; tissue is rebuilt; muscle tone is improved; nerve conductivity is restored.

The exercises should include both the base-out prism work described in this section and the exercises in general motility described on page 82. Out-of-door exercise, and gymnasium work if possible, should be insisted on. Diet should be regulated under the guidance of a competent alimentary specialist.

There is also the exophoria accompanying arrested development of the convergence-accommodation function. In these

cases the skiascope usually shows a manifest hyperopia and a considerable difference between the static and dynamic skiascopic findings. The plus thus found is seldom accepted, or makes little or no improvement in vision. The pupils are abnormally large. This one sign, the large pupils, differentiates the case from latent hyperopia. For small, or medium small, pupils are associated with latent hyperopia. Exercises with base-out prisms will develop the convergence-accommodation function.

There is an exophoria, or low tonicity, due to listlessness, to lack of concentrated attention. Kratometer exercises with base-out prisms will cultivate the habit of attention, of sharp muscular innervation and response. Cultivate the habit of concentration, the exophoria will disappear.

It is better, in all these exercises, to use a target that will excite attention. Hence, pictures are far superior to a light or a letter.

The purpose being to develop tonicity in the convergence muscles, that purpose is best served by repeating as many times as possible the jump that will make convergence necessary. Where the induction reserve is very low, it is necessary, in order to get this frequent repetition, to start below zero, with 6△ *base-in* (occasionally as much as 10△) from the rotary disks. If the induction test shows only 8△, this gives us only 4 jumps from each prism slide. By starting with 3△ *base-in* from each rotary disk, we can get 7 jumps. We are striving to create an innervational habit, and habits are formed by frequent repetition of the same act.

Whatever the amount of reserve induction in the initial exercises, do not carry the prism power quite to that point. Do not cultivate in the patient's mind the habit of "letting go," of relaxing the effort and seeing double. Keep ever before the patient's mind that he MUST SEE ONE IMAGE.

For the most part, advance the prism slides together. For the sake of variety, occasionally one of the slides may

be used alone, but this is to be followed at once by the use of the slide on the other eye. Our intent is to awaken binocular responsiveness in the fields of versions, surrounding the macular fields. We must incite the nervous elements of both eyes to gain this end.

Increase the prism power 1 △ at a step for each eye almost to the breaking point as shown in the induction tests. Then decrease the prism power at the same rate back to zero, then up again, down again, repeating the up and down movement 10 or 12 times without pausing for rest.

At the beginning, a pause of a second, sometimes more, is to be made between each jump, to permit nervous recovery. After a few days, an attempt can be made to shorten the pause. The length of the pause should conform to the patient's ability, physical strength and condition.

Always avoid fatiguing the patient. Those who are not physically robust should be treated with much care. A woman with digestive troubles can be very easily upset if the exercising is overdone. In such cases, often, at the beginning, a pause of two or three seconds between jumps is necessary. And in such cases, sometimes, one or two up and down turns is all that can be tolerated without nausea.

Over exercising at the beginning is apt to cause severe headaches and much distress. More is to be gained by beginning slowly and gently. When a little work can be done without causing exhaustion, the amount of effort called forth can be increased. As a rule, five minutes of exercising each day is quite sufficient. In some cases, two or three minutes is the maximum of safety.

Work first to increase the ease of performance in that amount of induction that the patient has. Then work for speed in the use of this same amount. When the exercises can be conducted without fatigue, nausea or headache, then begin to work for an increase of amount, but not until then. Increased amount will come very quickly after practice has

created the ability of handily using the lower quantities.

Sometimes, the amount of induction cannot be at all increased, but if we teach the patient to use easily the amount of duction and version he already has, we shall add wonderfully to his comfort and working capacity. A high reserve is undoubtedly of great assistance, but the quality of the innervational resource is of greater consequence than amount of induction.

Should the patient complain of a severe headache, that comes on a few hours after the exercise period, the refractionist has probably made an error in diagnosis and base-in exercises instead of base-out exercises should be given.

After the patient has learned to overcome the full power of the prism slides, additional base-out prisms can be turned in from the rotary disks, and the up and down movements of the slides continued as before.

In working up more power, advance one slide at a time, alternating between the two eyes. If diplopia results, tell the patient to make an effort to bring the two images together into one. Insist that he make the effort. But this is not to be done until he can handle the lower power with speed and ease. (Pages 160, 161.)

Sometimes, in making a great effort to maintain single vision, a spasm of the convergence is induced. Then when the prism power is reduced, relaxation of the interni does not follow, and the patient sees double with the lower power prisms although he saw singly with the higher power. For example, a patient may have an adduction of 23△, and we repeat several times the call for 23△ of extra convergence. If that 23△ was only obtained through a supreme effort of the will, he will maintain single vision with 23△, but the image will break at 20△. It is not well to overtask the convergence at any time. Do not call for so much energy that untoward results will occur.

We occasionally encounter a case where, after working up

to the full inductive ability and then decreasing the prism power, the single image is held until we return to zero or to within 1 △ or 2 △ of zero, and then diplopia occurs. This indicates fatigue, over effort has been demanded. This is sufficient proof of an error in diagnosis. The low induction is due to stress, or tension, the convergence effort is already being habitually overworked, base-out prisms force still more effort. Reverse the prisms, give base-in exercises. This will break down the tension, the induction will then be good. So will all the other ductions.

Just as there is occasional suspension of vision, which is really loss of attention on the part of the secondary, or brain, visual centers connected with the suspending eye, so is there occasional lapse of version due to inattentiveness of the version centers. A person may have a reserve induction of 20 △ or 30 △, yet sometimes diplopia may occur at any lower power. If such a patient says, "Two", while the slides are being advanced, simply pause and say, "Make it one." This he will promptly do. When the attention of the version centers is thus recaptured, slide advances are continued. In treating this type of case, the aim of the exercises is to cultivate the habit of continued attention from the version control centers. They must be taught the habit of constant and unremitting attention to their task.

As in the induction tests, always keep before the patient's mind that he is to speak immediately if the object seems to move to one side, or if he sees two images instead of one. Some people are not good at keeping the operator promptly advised. These must be strongly urged, for their own benefit, to speak immediately when they see two objects or when the object seems to move sidewise.

From the beginning, give exercises with the vertical prisms as well as the horizontal. (Page 85.)

After a week or so (the time depending on the seriousness of the case and the results being obtained) commence exer-

cises in adjustments at different positions, as described under that heading. (Page 82.)

Exercises at the near point should also be given. But in very bad cases, these cannot be undertaken at first.

In convergence exercises always return to zero before permitting the patient to withdraw from the instrument. This to avoid dizziness and nausea. In very bad cases, especially if the digestion is involved, permit the patient to remain seated three or four minutes after concluding the exercises, before attempting to walk.

Starting at zero with both prism slides, advance both to 1 △. Then return both to zero. Then advance both, by 1 △ steps, to 2 △. Then reduce both, by 1 △ steps, to zero. Then advance both, keeping always to the 1 △ steps, to 3 △, returning, by 1 △ steps, to zero. Then, in the same way, to 4 △ and back to zero. Then to 5 △ and back to zero. And so on, going 1 △ higher on both eyes at each successive exercise and always returning down to zero after each advance. This gives alternate innervation and inhibition, alternate flexion and relaxation, is often far better, far easier, hence, more successful, than trying to go to the extreme limit in the first exercise.

These exercises are to be given with the distance correction, if such is worn, in the rear lens cells. There is a distinct advantage to be gained, if the accommodative amplitude is also low, by putting -0.50 or -0.75 spheres in the front lens cells. But this should not be done in those cases where the full plus correction increases the exophoria, for in those cases the purpose of the exercises is to develop convergence independently of accommodation.

Usually, after two or three weeks of regular Kratometer treatments, the patient will voluntarily remark that his eyes are more comfortable. Exercises should be continued for a week or ten days after all disagreeable symptoms have vanished.

Do not discontinue the exercises until the slides can be

moved up and down with extreme rapidity without causing diplopia, nausea or fatigue.

Under no circumstances should base-out exercises be given in cases of esophoria or myopia, for this would increase the patient's trouble. Give convergence relaxation exercises to esophores and myopes.

EXERCISES FOR DEVELOPING THE CONVERGENCE-ACCOMMODATION FUNCTION

MANY young people come to the refractionist complaining of difficulty with near work, especially students, stenographers and others who spend all day at very close work. A slight refractive error may be found, or no error at all. But the reading point tests show the necessity of plus lenses as an aid to clear vision, and the amplitude of convergence-accommodation is low. These have been classed as "Premature Presbyopes." (Pages 130-133.)

These young people are not "presbyopic." These are cases of arrested development of the convergence-accommodation function. Large pupils are usually to be noted, which is one of the symptoms guiding to correct diagnosis. For pupillary contraction is an associate of the convergence-accommodative function.

Instead of giving these young people "special reading glasses," with plus lenses that will tend to repress and still further weaken the accommodative function, give them base-out exercises for ten days or two weeks with the Kratometer Prism Jump System.

The exercises are at the near work distance. Use Chart No. 11, and prepare other similar cards, pasting small pictures, stamps, seals, etc., on white cards. This gives a variety, which helps to awaken and sustain interest. The exercises are given in the same manner as the exercises for low tonicity, excepting that no time need be spent on the dis-

tance exercising. Ten to fifteen minutes daily can be spent, and there is rarely any after effect of headache or nausea. If time and opportunity afford, two sessions a day can be given.

Use also stereo cards, and the exercises at different positions as described in other sections.

This is decidedly a better way of treating those cases than imposing on them the burden and annoyance of glasses. A great many times, innervational habits can be educated that will render unnecessary the correction of slight structural refractive errors. (Pages 130-133.)

The same treatment is to be given to early presbyopes, whose required reading addition is in excess of that normally to be expected at their age, excepting in esophoria cases.

The use, part of the time, of -0.50 and -0.75 spheres in the front lens cells is advisable.

EXERCISES FOR THE RESTORATION OF BINOCULAR FUNCTIONS

One of the most troublesome symptoms arising in the course of such diseases as high blood pressure, toxic infections from diseased sinuses, tonsils, teeth, etc., is the loss of associated control of muscles that are normally synergistically innervated.

Innervational ocular exercises cannot be given to patients while they are suffering from these diseases.

Often, after the progress of the disease is stayed, and after recovery is apparently complete, binocular imbalances persist.

Then a course of Kratometer exercises will prove highly beneficial. Often suspensions appear, and to those appropriate exercises should be given. And exercises as in convergence and accommodative insufficiencies are to follow. The operator must carefully guard against over-exercising these cases.

Among other beneficial results, these exercises incite the

circulation of the blood. Toxins and debris that have accumulated will be pumped out and carried away. Muscular tone is recovered, together with the innervational habits that were lost because of disease.

EXERCISES IN MOTILITY AND SPEED OF ADJUSTMENT IN VARIOUS POSITIONS

MANY workers, such as typists, bookkeepers, certain machine operatives, etc., are troubled at their work, not because of lack of accommodative or convergence amplitudes, but because of slow motility and lagging adjustments. They are unable to quickly transfer vision and binocular functioning from one object to another.

Many motor accidents are due to slow reflex adjustments. The trouble is not visual, there may be normal macular vision and full efficiency of the peripheral fields. The one thing that is lacking is quick adjustment.

In all cases of suspension and suppression, motility and quick adjustment are characteristically lacking.

These exercises in motility and adjustments for different positions, which are easily and efficiently carried on with the Kratometer, are impossible with any other apparatus yet devised.

After the possibility of suspension is eliminated, these exercises should be instituted.

For motility exercises at distance use Chart No. 1, or a picture or letter. For near work use Chart No. 11, or a similar picture.

Put the proper correction in the rear lens cells. Adjust the pupillary distance. Set the rotary disks at ZERO. Insert the horizontal prism slides in the brackets, with prisms base out.

With the patient in comfortable position, push the right slide down to 13△ *base-out*. Both slides now extend below the batteries. The right slide is at 13△ base-out, the left

slide is at zero. The right eye is turning in considerably, while the left eye is converging but slightly. Push both slides up, one notch at a time, and not too rapidly at first. As the slides move upward, the left eye is drawn inward while the right eye, step by step, relaxes its convergence. At every step the comparative positions of the two eyes change. When the prisms are half-way up, both converge to the median plane. Beyond this, the left eye converges more, the right eye less.

When the slides have passed their entire length, reverse the movement, work all the way down, then return up, and continue this through ten or twelve turns.

As the slides move upward, the object seems to hop to the right; as the slides are drawn down, the object seems to travel to the left. At every one of these jumps of the position of the object, the eyes must make a new adjustment of accommodation and convergence.

When the patient has become accustomed to this movement, so that the exercise can be given at a very rapid rate, without causing dizziness, various other positions may be brought about by turning in prisms from the rotary disks.

Turn in 5△ base-out over the right eye, and exercise. Then turn in 5△ base-in from the left eye, and repeat the exercises. This turns both eyes to the left. Then turn in 10△ base-out over the right eye, and repeat the prism slide movement. Then 10△ base-in from the left disk. The eyes are now being exercised while turned far to the left. Then 15△ base-out from the right disk, which brings about exercises at still another position.

The same series of exercises are to be performed with both eyes turned to the right, starting in with 5△ base-out over left eye, then 5△ base-out over left and 5△ base-in over right, then increasing the right disk prism to 10△, next bringing the left disk prism up to 10△, and finally the left up to 15△.

Between each change of disk prism power, the up and down movements of the slides are to be repeated from six to twelve times. Do not hurry the speed at first, but finally a very rapid gait can be set up, the slides being moved up and down with no stops at the notches.

Exercises with the vertical prism slides are to be given in the same way, with different combinations of prisms from the rotary disks. Use 3△ both base-in, 3△ both base-out, 3△ base-out with 5△ base-in, 5△ both base-out, 10△ both base-out, 5△ base-in with 10△ base-out, and so on in almost infinite variety.

Turn in 5△ base-up from both disks, and give the exercises with the horizontal prism slides. Then turn the 5△ disk prisms over to base-down and repeat the exercises. This is much more difficult than with the disk prisms both at base-up. Also, give the exercises with 10△ base-up from both disks.

It is impossible to set down all the combinations that can be worked out for turning the eyes into different positions and educating them to make rapid adjustments whenever and in whatever position may be required. Suffice it to say that these exercises are fully as important as the exercises whose sole aim is to develop more induction or abduction reserves.

But this must be added, the higher the reserve induction, the greater the variety of these motility exercises that can be given. Where the induction is high, it is possible to give these exercises with as much as 25△ base-out from one rotary disk with zero from the other.

Exercises in convergence relaxation with the horizontal slides at bases-in, and exercises for increasing convergence with the horizontal slides at bases-out, should also be given with both eyes turned to the right, by using 5△ or 10△ base-in from the right rotary disk and 5△ or 10△ base-out from the left rotary disk, as described in preceding para-

graphs. Likewise, the same exercise is to be given with both eyes turned to the left with the proper arrangement of the rotary disks. And add further variety by turning both eyes upward and downward, using 5△ from both rotary disks at base-down, and with both at base-up.

One of the most valuable exercises in all cases of low ductions is to turn both rotary disks to 3△ base-in, then, with both prism slides turned in the same direction, prism apices pointing to the right over both eyes, both set at zero, both set so that the first step shall be to the 1△ prisms, the second step to the 2△ prisms, and so on, move the slides up and down, with a fair degree of slowness at first, then with constantly increasing speeds, causing both eyes to turn to the right by successive quick jumps, then back to the left in the same way. The base-in prisms hold excessive convergence inhibited, tensions are broken down, flexibility and facility of adjustment are soon inculcated.

After a few days, change to the 5△ prisms, bases-in, from the rotary disks. Then to the 10△, bases-in.

Such exercises in general motility will soon educate in the fiber tracts the flexibility of re-associations so essential to comfort. The ductions will become good, indicating freedom from stresses and interferences with the deliveries of innervating currents.

VERTICAL EXERCISES

The vertical muscles are to be exercised daily even if no vertical disturbances are manifest. For such exercises increase general ocular motility and greatly shorten the time that is to be spent in building up horizontal reserves.

If the reserve vertical ductions are not above 3△ or 4△, give particular attention to their development. A reserve vertical duction of 6△ to 7△, binocularly, can be developed, and is a great asset to the person possessing it.

If there are suspensions or suppressions, use Charts 4, 5, 6, 7 and 8, with the rotary disks set at the required 10 △ base-out over each eye to fuse the two pictures into one, using the vertical slides for the exercises. If there is no tendency to suspension or suppression, use Chart No. 11 and similar pictures.

For the exercises, adjust the instrument as in taking the vertical ductions. In exercising, work for speed in overcoming the lower powers before attempting to increase the amount. Do not advance the power to the blurring point, but stop at one or two steps below that point and return to zero.

Exercise the right inferior rectus against the left superior rectus by using the right vertical slide at base-up and the left vertical slide at base-down.

Exercise the left inferior rectus against the right superior rectus by using the left vertical slide at base-up and the right vertical slide at base-down.

Thus the prism apex is always over the muscle whose innervation we are inciting, that is, the direction in which we desire to increase duction.

Give these vertical exercises with various combinations of base-out and base-in prisms from the rotary disks, as described in the section on "Exercises in Motility and Speed of Adjustment in Various Positions." The importance of vertical exercising with varying amounts of convergence in use, and with the eyes turned to right or left, cannot be over-emphasized.

TREATMENT OF HYPERPHORIA

If hyperphoria is manifest, before attempting its correction make sure that it is not caused by high blood pressure, or from focal infections, such as decayed teeth, diseased tonsils, adenoids, nasal passages, sinus disease, or other toxic conditions.

If sure that it is a true hyperphoria, do not give vertical prism with the base "over the weak muscle." This may give a little temporary comfort, but it will eventually lead to further weaknesses and will finally result in loss of equilibrium. The way to treat hyperphoria is to build up equality of vertical ductions.

Give exercises only in the direction of the weak innervation. If the duction tests show that the antagonistic ability of the right inferior rectus against the left superior rectus is greater than that of the left inferior rectus against the right superior rectus, exercise the latter pair only. Or if the reverse is the case, if the right inferior rectus against the left superior rectus shows the lower duction, the exercises are to be confined to this pair.

If the left eye shows a tendency to turn up, or the right eye shows a tendency to turn down, it is because there is insufficient innervation to the left inferior and the right superior recti, with proportionate over-innervation of their antagonists, the right inferior and left superior recti. Inhibit the innervation of the latter pair and incite the innervation of the first pair by exercises with the right vertical slide at base-down and the left vertical slide at base-up.

If the right eye shows a tendency to turn upward, or the left eye shows a tendency to turn downward, it is because of insufficient innervation to the right inferior and left superior recti with over-innervation of their antagonists, the right superior and left inferior recti. Inhibit the latter and innervate the former by exercises with the right vertical slide at base up and the left vertical slide at base down.

These exercises develop in the central nervous system the habit of properly distributing innervation and inhibition, so that the tendency to hyperphoria disappears.

A desirable addition to daily exercising of the verticals, when ductions are unequal, is the prescription of a weak prism for constant wear with the apex in the same direction

as the exercises are being given. It is usually better to divide the power equally between the two eyes. Such prism is to be discontinued when the exercises have built up equality of ductions.

Vertical ductions and exercises must always proceed at a slow rate, with ample pause for recovery between each prism jump. Postpone attempts to increase speed until response becomes steady and sure. (Pages 161, 162.)

EXERCISES WITH THE SLIDES AT OBLIQUE ANGLES

An addition to the motility exercises is the use of the horizontal and vertical slides tilted obliquely. Loosen the set screws (12–12) of the adjustable brackets and turn the upper ends of these brackets toward each other about 5 degrees. Insert the horizontal slides, bases-out, and give the convergence and other exercises described in previous pages. After a few turns with these, insert the vertical slides and repeat former exercises.

Then turn the brackets so that the upper ends are tilted away from each other about 5 degrees and repeat the exercises, using both horizontal and vertical slides.

In giving exercises for low tonicity, tilt the upper ends of the adjustable brackets about 15 degrees inward and use the horizontal slides with bases-out. When the brackets are tilted as much as this, use the slides in alternation, otherwise they interfere with each other. Five or six turns to each eye, then tilt the brackets a little more, to about 15 degrees. Absolute accuracy in the degree of tilting is unimportant.

Convergence is normally both inward and downward, the inferior recti participate to no inconsiderable degree. These exercises with the slides in oblique position, develop the convergence ability very rapidly.

In esophoria and myopia, where we seek to develop con-

vergence relaxation, use the brackets in the same positions as above, but turn the horizontal slides to base in. The apex is then out and up, and the innervation is thus driven away from the association of internal and inferior recti.

EXERCISES FOR DEVELOPING FUSIONAL HABIT

MANY people suffer visual inconveniences from imperfect habit of binocular fixation, or "fusion." While we cannot, in view of more recent concepts of binocular perception, accept much that has been written about "fusion," "fusional sense," "fusional desire," the fact remains that exercises with such charts as Nos. 5 to 10 bring about happy results. These cases are characterized by low ductions, slow motility, suspension, suppression, cyclophorias, hyperphorias, dizziness, etc., which have been sufficiently discussed under their appropriate headings.

EXERCISES FOR SQUINT

IT is doubtful if exercises alone will straighten the eyes in either convergent or divergent squint. But by developing the habit of fusion, or by retarding the loss of that habit, and by the development of visual acuity, or by retarding the onset of amblyopia ex anopsia, the refractionist will find his task made much easier by giving exercises with Charts 5 to 10.

There may be some difficulty in so adjusting the prisms as to place the images on both foveas, but the Kratometer is susceptible of so great a variety of adjustments that few instances can arise in which such positioning is impossible.

After this combination of positioning prisms is found, proceed to jump the slides one step at a time, pausing for several seconds between each step to give plenty of time for recovery of nervous conduction and recognition of the test object. With the horizontal slides work in both directions, increasing and decreasing prism power. And with the vertical

slides work for both supra- and infra-ductions. Make no attempt at many steps in the beginning. Be content with adding one or two steps per day to the motility.

In convergent squint, the most of the effort should be directed toward increasing abduction. In divergent squint, try to build up response to the call for induction. Guard constantly agains suppression or suspension.

If the squinting eye is amblyopic, as is usually the case, follow the methods described under "Exercises for Amblyopia Ex Anopsia." (Page 95.)

Exercises for alternating squint have already been described on page 62. Also use the technic outlined under "Exercises in Motility". (Page 82.) Such exercises awaken attention, when attention is awakened, when the exercises have broken down obstructions and tensions, the reflex arcs leading to rotation of the foveae beneath the images will become effective, the alternating fixation will cease. No method for correcting this defect was known until Kratometer methods paved the way.

EXERCISES AFTER CORRECTION OF SQUINT

After the squint is overcome, by either glasses or operation, the refractionist's duty is not completed until the pair of eyes has been taught to function binocularly.

There are plenty of instances where the squinting eye straightens on the application of the repression of the plus correction to convergent squint, but the formerly squinting eye does not take up the act of vision. Instead, it suspends most of the time, and the visual centers never learn the secret of fusion with the images presented by the other eye.

If this eye is amblyopic, give exercises for the development of acuity as described in another section. (Page 95.)

Give daily exercises to overcome the habit of suspension. When acuity and freedom from suspensions are well developed, begin exercises to develop the sense of stereopsis.

Do not discontinue these exercises until the patient is in full possession of all the functions and advantages of binocular vision.

SECTIONAL ASTIGMATISM

Sectional astigmatism, or meridional contraction of the crystalline, will give way to exercises in convergence relaxation. (Page 133.)

Also, in those cases in which the accommodation covers part of the astigmatic error, so that the patient will accept but a part of the true cylindrical correction, relaxation of the convergence and dissociation from the accommodation may be brought about by Kratometer exercises with prisms, base-in.

When the patient will not accept the cylinders indicated by the ophthalmometer as needed in correction of the corneal error, and, as is often the case, even skiascopic findings fail to reveal the astigmatic error, give exercises in convergence relaxation, then refract the case with base-in prisms in the Genothalmic Refractor. Sometimes sufficient relaxation can be obtained in a single examination by this method to enable the patient to accept with satisfaction the desired cylindrical correction. Such exercises should also be given before the finished glasses are adjusted, and frequently may be repeated daily for several days.

The astigmatism must be corrected in full or trouble will be experienced in the cross-cylinder check tests. The following procedure is often effective: Use the Kratometer with Chart No. 2 set at the reading distance. Using the horizontal slides with their prisms *base-in*, relax the convergence to the utmost, leaving all the prism in place that can be tolerated without diplopia. Overcorrect the astigmatism in both eyes by at least 1 D. of plus cylinders, so that one set of lines is decidely blacker than the other. In astigmatism with the rule, the horizontal lines will come out the stronger; against

the rule, the vertical lines will be blacker. Then reduce the cylinders by eighth-diopter steps until both sets of lines are of equal blackness. The cylinders left in place will be found to closely approximate the expectation from the ophthalmometer readings. The test is made with both eyes uncovered. Check each eye separately by quick occlusion of the other. Prolonged occlusion will permit the convergence and associated accommodation to reassert themselves, which must be avoided.

In non-presbyopes with low hyperopic error, this correction is to be made without spheres, the spherical correction being determined by the cross-cylinder method. In presbyopia or high hyperopia, some plus sphere must be used to give vision of the chart.

If the full plus astigmatic correction should increase the amount of exophoria, as it frequently does, it may be necessary to prescribe for temporary use some base-in prism to hold the convergence in check, and to give relaxation exercises with the Kratometer to break down the association of convergence and accommodation.

Sometimes, in cases of simple hyperopic astigmatism, after the astigmatism has been fully corrected, it may be necessary to use weak minus spheres to secure binocular balance and clear, comfortable vision.

Frequently, what seemed at first a slightly oblique axis, will be found vertical after the convergence-accommodative strain has been relieved. An axis of 85, 80, 95 or 100 will right itself and come to 90 after the sectional accommodation and the convergence effort that caused it have been repressed.

In many cases of arrested development of the convergence-accommodation function, particularly among adults, cylinders at a ten or fifteen degree obliquity from the vertical are often found. Frequently the axes shift from week to week. After giving base-out exercises with the Kratometer, arousing

attention and a better activity of this function, these astigmatic axes generally move to a stationary position at or near 90 degrees.

In myopia, frequently there is an accompanying distortion of the cornea, a temporary, or spurious, corneal astigmatism, which, like the myopia, can be partly, sometimes wholly, reduced by base-in exercises with the Kratometer and by base-in prism wearing. The amount of the prism is to be determined by the abduction test as described on page 135. In general, it seems unnecessary to prescribe low power minus cylinders, inadvisable to correct high myopic astigmatism in full. For after proper Kratometer exercises, the amount of corneal astigmia will be materially reduced.

OBLIQUE ASTIGMATISM, TORSIONS AND CYCLOPHORIA

In oblique astigmatism, there is often considerable doubt as to whether the cylinder axes found in the monocular test are correct binocularly. To check these axes use Chart No. 3, set at 35 cm., and with the stereo septum in place. Leave the rotary discs at open and insert the horizontal prism slides with bases-out, set at the zero openings. Insert the correction found in the rear lens cells. (Pages 47-49.)

Direct the patient's attention to the squares of horizontal and vertical lines, first to the right squares, occluding the left eye, then to the left squares with the right eye occluded.

If the cylinder axes are incorrect, the lines, instead of appearing true, will be zig-zagged. Adjust the cylinder axis until the lines are true. This is the monocular check.

Adjust the horizontal slides to that power which in the phoria test was found to fuse the E. If the cylinder axes are binocularly correct, the lines will appear true, but if there is a torsion, the lines will be zig-zagged. Adjust the cylinder axes until the lines are true. Sometimes the zig-zag effect is

due to incorrect cylinder strength, and this will have to be modified. This check test will prove the correctness or incorrectness of the cylindrical lenses when the eyes are functioning binocularly, and that in a manner that leaves no room for doubt.

Oblique astigmatism and torsions are so commonly associated that monocular astigmatic corrections are usually binocularly at fault. With the special Kratometer stereophoria and duction tests, the tendency to these torsions is at once disclosed, and the refractionist is placed on his guard.

In using Chart No. 4, when the line of horizontal dots breaks into two lines, if there is a tendency to cyclophoria, one or both lines will turn from the horizontal to an oblique position, forming an acute angle. (Pages 57, 168.)

If such evidence of cyclophoria is found, and there is complaint of ocular discomfort, it will also be found that there is either imbalance between convergence and accommodation or that there is a convergence insufficiency or that the vertical ductions are unequal.

In using Chart No. 3, sometimes one or the other of the letters will appear higher than the other and the patient will see one of them in a tilted position. This is evidence of cyclophoria, and often a cyclophoria will present all the evidences of hyperphoria.

The proper procedure is to establish innervational balance in binocular functions. Make sure that accommodative and convergence requirements and efforts are equalized. Be sure the cause is not latent hyperopia. Develop equality of ductions in the vertical antagonists, and speed and surety of adjustment in the versions by the exercises given in preceding pages. Particular attention to the cyclophoria itself is seldom necessary.

So long as the innervational resources are sufficient to care for structural errors, the errors in themselves are of comparative unimportance.

One who wishes to study torsions and cyclophoria in detail, will find an ideal apparatus in the adjustable stereo features of the Genothalmic Kratometer.

The experimental use of the Kratometer in the study of those peculiarities known as cyclophorias, torsions and declinations, will soon convince the thoughtful mind of the utter futility of the much advocated exercises with "Swinging Cylinders" or the prescription of oblique cylinders. Innervational exercises in motility in all directions, given under the Kratometer system, will very quickly educate the innervational centers to care for any torting tendencies, and that without undue "muscular" effort or strain.

AMBLYOPIA EX ANOPSIA: DUCTIONS AND FUSIONAL AND VISUAL EXERCISES

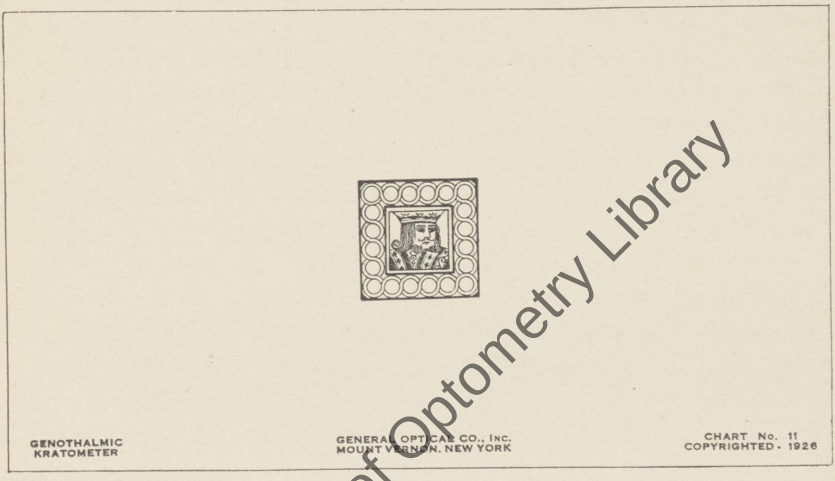


Chart No. 11

USE Chart No. 11. The border is red with the central figure black. This chart is not only to be used in the exercises below with a red glass, but is used as fixation object without the red glass in the various tests and exercises described in previous sections.

Set this card on Kratometer rod at the usual reading distance, 35 to 40 cm. from the eyes, and insert reading correction in rear lens cells.

Turn in the red glass from the rotary disk in front of the good eye. This eye will now see the red border of the target as a very pale pink. To some people, even this pinkish tint will not be apparent, the border will be entirely invisible. The red of the card is absorbed by the red of the glass. The disk in front of the amblyopic eye is left at OPEN, so that the bright red is presented to the amblyopic eye.

Put one or two smoke color lenses in front of the good eye to reduce the luminosity to that eye. In this way, with illumination reduced to the good eye but kept at full strength to the amblyopic eye, the latter will receive stimuli equal to the stimuli entering the good eye.

Call patient's attention to the two targets he sees, the pale pink by the good eye, the bright red by the amblyopic eye. If he does not see the bright red target, cover the good eye so that the attention of the amblyopic eye will be captured. Then uncover good eye, and he will probably hold both images. If not, cover and uncover good eye rapidly until he does retain both images.

Any difficulty in getting continued attention of the amblyopic eye will be solved by adding more smoked lenses over the good eye, reducing the intensity of stimulus to that eye, correspondingly increasing the stimulus to the amblyopic eye.

Insert enough horizontal prism (base-in if the eye turns out, base-out if the eye turns in) over the amblyopic eye to bring its image to its fovea. Use both rotary disks and the horizontal prism slides. If one image is higher than the other, insert enough vertical prism (base-up or base-down, as required) over the good eye to bring the two images to horizontal alignment.

By careful adjusting of horizontal and vertical prisms, the two images are finally superimposed.

When the two images are superimposed, the patient will see the bright border only, but it will be less bright when fused by the two eyes than when seen by the amblyopic eye alone. When the amblyopic eye suspends, patient will see the dull pink target only. Cover and uncover good eye until amblyopic eye retains vision.

Vertical ductions are taken by changing power of vertical prism over good eye. Steps cannot exceed ¼ prism diopter.

Horizontal ductions are taken by changing power of horizontal prism over amblyopic eye. Steps cannot exceed one diopter.

Remember these two points: Vertical ductions are taken by moving the vertical slide up and down over the good eye. Horizontal ductions are taken by moving the horizontal prism slide up and down over the amblyopic eye.

Exercise by changing prism power over amblyopic eye only. Often not more than one diopter change can be made at first without causing diplopia. Shift prism power back and forth within the limits of single vision, three or four seconds' time interval between each change. Never go to the point of double vision. Watch for suspension by amblyopic eye. This will be known by instructing the patient to speak instantly if the bright red border disappears.

Two or three minutes at a time of this exercise are sufficient. Do not cause fatigue. Exercises during the fatigue period are harmful. Rest frequently. After a few days, it will be found that the number of prism steps can be increased, the time interval between prism jumps can be shortened.

This method of exercising puts into effect certain known physiological facts: Red attracts more attention than does any other color; a jumping red object attracts more attention than does a stationary red object or a swinging red object; attention is attracted in proportion to the vividness of the sensation and the suddenness of the sensation; muscular response is in proportion to the attention awakened by the

vivid and sudden sensation. The bright red object, with greater luminosity to the amblyopic eye than to the good eye, since the brightness has been reduced to the good eye by the red and smoked lenses, when suddenly moved from the fovea by the prism jump, attracts attention. Attention once attracted, visual development follows.

After a few minutes of this exercise, cover the good eye, and have patient read with the amblyopic eye alone for a few minutes. If vision is very poor, use the advertising pages of magazines, and let him pick out such letters as he can see or guess at.

Daily improvement in acuity and fusional habit will be noticed. Check correcting lenses frequently and change as necessary. The amblyopic eye, as acuity increases, will doubtless need several lens changes before final correction is established. As fusional habit improves, it will usually occur that vertical prisms are no longer needed.

For distance exercises, draw rough sketches with red and black crayons on white cardboard. Make lines heavy. If vision in amblyopic eye is not too poor, very often the reds and blacks of some of the popular magazine covers provide excellent exercise pictures.

Provide yourself with a great variety of red and black pictures for the near work. Christmas and birthday cards, sold in stationery stores, are excellent. Remember that interest is the main essential and that interest flags when the same picture is used over and over. So have dozens of different pictures, red and black, always at hand and change every few minutes.

When vision in the amblyopic eye is extremely poor, so poor that the red of Chart No. 11 cannot be seen, draw large circles, squares, triangles, etc., on white cards. These may be from one inch to six inches or more in diameter, as the case requires. They may be made with wide black borders around solid red centers, or vice versa.

In extreme cases, use a brilliant red electric bulb set in a black box with an opening from two to eight inches in diameter through which the red light is seen by the patient. Then, with red and smoked lenses over the good eye, the good eye sees a black box with a light pink light, the amblyopic eye sees the red light. Adjust the prisms so that the red light appears to be in the black box and proceed with the prism jumps to the amblyopic eye as above described.

If the eye can see light only, even if cannot recognize form, so long as it is not a pathological case, good vision can be developed with the Kratometer methods. This is the first method that has been developed that will bring good vision to such eyes. Heretofore, such cases have been hopeless.

Acuity develops more rapidly under the Kratometer innervating impulses than by any other method. Surprising results are attained. We have many instances on record where eminent specialists have stated that nothing could be done in the way of improving vision in amblyopic eyes, yet with Kratometer exercises vision has been brought up to normal in a few weeks. We have such records of developed vision in adults of from 30 to 57 years of age.

Distinguish between amblyopia ex anopsia and amblyopia because of disease, as high blood pressure, diabetes, etc.

CONVERGENCE-ACCOMMODATION RELATIONS

THE CROSS-CYLINDER CHECK TEST WITH THE KRATOMETER

The prime essential of Binocular Balance is the equality of effort in associated and synergistically innervated accommodation and convergence. The function of lenses and prisms is to bring about this balance.

Over-correction of hyperopia with exophoria may bring about imbalance. The careless prescription of prisms in the correction of exophoria may bring about imbalance. Visual

tests alone will not give information as to the correctness or comfort-giving qualities of lenticular prescriptions. The old rule to deduct "about 0.50 D. or 0.75 D. sphere" from the accepted monocular corrections in hyperopia with exophoria is abhorrent to the refractionist who seeks precision. The rule to give prism to the amount of "about one-third to one-half of the manifest error" in exophoria is but crude guess work.

The following procedure provides an adequate check against failure in leaving a delicately adjusted balance between convergence and accommodative requirements, and will show just what prism, base-in, if any, is required.

With the cross-cylinder in place over a correcting lens or combination of lenses, the near correction is correct, there is balance of functions, if the cross-cylinder makes a slight blur, and an equal blur, of the horizontal and vertical lines of Chart No. 2.

The slight blur is necessary, otherwise the test is of no avail. Since different eyes have apparently different "depth of focus," one and the same strength of cross-cylinder will not serve for every eye. The following four pairs of cross-cylinders must be prepared and mounted in trial rings to fit the front lens cells of the Kratometer.

No. 1. −0.25 Sph. ⊂ +0.50 Cyl. Ax. 180.
No. 2. −0.50 Sph. ⊂ +1.00 Cyl. Ax. 180.
No. 3. −0.75 Sph. ⊂ +1.50 Cyl. Ax. 180.
No. 4. −1.00 Sph. ⊂ +2.00 Cyl. Ax. 180.

In use, these cross-cylinders are always set with the plus axis at 180.

Before attempting to use the cross-cylinder check, make sure that the patient sees all the vertical and horizontal lines of the cross equally clear. Astigmatism must be corrected in full. In some cases of high blood pressure, focal infections, incipient cataract, and in many cases of unde-

veloped retinal terminals, the lines cannot be made to appear equally clear. In that event, do not attempt to use the cross-cylinder check for accommodative-convergence balance.

Next, by a quick test, find what power cross-cylinder will produce a slight blur. In cases of high visual acuity, and especially in accommodative esophoria with small pupils, the higher strength cross-cylinders will be necessary. In low visual acuity, in myopes, in exophoria with large pupils, the lower powers will prove better. Many times, different powered cross-cylinders must be used on the two eyes.

FINDING THE LATENT HYPEROPIA

Arrange the Kratometer as in the phoria test, the batteries set at the correct interpupillary distance for near vision. The horizontal prism slides are inserted in the brackets with prism bases-in, and set at the zero openings. Turn the *left* rotary disk to 3 △ *base-down* and the *right* rotary disk to 3 △ *base-up*, or to whatever other combination of right and left prisms was found, in the phoria test, to produce vertical diplopia. Remember that the upper cross belongs to the left eye and the lower cross to the right eye.

The correction, as found by other objective and subjective methods is placed in the rear lens cells.

Direct the patient's attention to the lower cross (right eye) and inquire if the horizontal lines are blacker and clearer than the vertical, or if the vertical are the blacker, or if both sets look equally blurred.

Make the same inquiry as to the upper cross (left eye).

If the horizontal lines are blacker, plus sphere is to be added. If the vertical lines are blacker, plus sphere is to be deducted.

In adding or subtracting plus for either eye, if the accommodation is active, it is probable that the appearance of the lines will be changed for the other eye. Add or subtract plus to equalize the appearance of both sets of lines to both eyes.

If there is a manifest exophoria, insert prism, base-in,

from the horizontal slides, of equal amount to both eyes or as nearly equal as possible, until the two crosses are in vertical alignment. This prism is not to be included in the final prescription. But if the horizontal lines are plainer to one or both eyes and the addition of more plus sphere to equalize the lines should move the upper cross to the right, ever so little, the latent exophoria is being revealed and extra prism, base-in, must be added to once more bring the crosses to vertical alignment. This extra prism is to be made a part of the final prescription, for constant wear.

Very often, this addition of extra prism, in correcting the latent exophoria and thus relaxing the convergence, will also relax the accommodation, revealing more of the latent hyperopia. If this happens, the horizontal lines will come out black again. Add plus to equalize the lines and inquire if the upper cross has again shifted to the right. If so, add more base-in prism. This is continued until no more plus can be added without making the vertical lines clearer than the horizontal, nor can more prism be added without shifting the upper cross to the left.

The full amount of the latent hyperopia can be uncovered by this method, and without the use of atropine. In fact, this method usually reveals more latent error than atropine does, due to the fact that atropine cannot inhibit spinal sympathetic innervation of the meridional fibers of the ciliary muscles.

When the addition of base-in prism does not make the horizontal lines appear blacker and plainer than the vertical lines, nor does the addition of plus spheres make the vertical lines clearer than the horizontal, the full error has been uncovered.

This is a binocular method of monocular testing. Neither eye is to be occluded. The convergence and accommodative functions are both under test, they are studied simultaneously, the effect on either of repression of the other is shown.

Where the static refraction of the two eyes is different, the true difference is here made manifest. Often, by ordinary

skiascopic and subjective tests, the two eyes are apparently different, but by this cross-cylinder method it will often be found that the two eyes are equal. Again, ordinary tests may show the two eyes as similar, while they are actually not statically equal, as will be proved by the cross-cylinder method.

Remove the cross-cylinders and turn out the vertical displacing prisms, leaving the full plus correction and base-in prisms in place. Now reduce, slowly, the base-in prism, substituting some printed matter in lieu of the chart. Spend a few minutes in giving base-in exercises, that the convergence-accommodation impulse may be inhibited. Try to get this so relaxed that the patient can read through the plus lenses without blur. Sometimes, though seldom, it is necessary to leave 2△ or 3△ base-in prism over each eye to restrain the convergence-accommodation habit, so that the patient can read clearly through the full plus. Sometimes it is necessary to reduce the plus somewhat, but do not do this until spending ten or twelve minutes on base-in relaxation exercises.

Then, with whatever plus correction is thus accepted and with the refractive difference between the two eyes properly corrected, replace Chart No. 2 and the cross-cylinders and once more study the latent exophoria and latent hyperopia. But this time do not use the vertical displacing prisms, but make the test binocularly, both eyes fixing the single target. This will verify the monocular method already used.

In the binocular method, add base-in prisms, equal before the two eyes, until the horizontal lines come out black. Then add plus sphere to equalize the lines and add all the plus sphere possible so long as the lines remain equal. Then add more base-in prism until the horizontal lines again come out black, then more plus sphere to equalize all lines, then more prism and more sphere, continuing to the point of diplopia. The proportions of latent hyperopia and latent exophoria can be thus studied.

The two methods check each other and verify findings. If

one wishes, by leaving this plus sphere in place, the near abduction can be further developed up to 40△ or 50△ or even beyond. But no further latent hyperopia will be found.

When the question arises as to whether to give base-in or base-out exercises, the decisive answer is to be found by uncovering the latent hyperopia. If this be more than 1 D., it will be safe to assume that any manifest convergence insufficiency is due to exhaustion from lack of sufficient plus correction. Base-in exercises are to be given and more plus prescribed as quickly as possible. It may take several weeks of daily exercises and several changes of glasses before the needed correction is accepted with clear vision.

Only when it is definitely known that the efforts involved in maintaining the latency of a latent hyperopia are not the cause of the manifest exophoria, is it safe to give exercises with base-out prisms.

In presbyopic cases where the reading addition is noticeably greater than the amount to be expected at the patient's age, we may justly suspect that the full hyperopic error has not been uncovered. The above method, in its combined repression of the convergence and accommodation by prisms and plus spheres, will make manifest and correctible both the latent hyperopia and the latent exophoria. As these are somewhat difficult cases to handle, many times, especially when the convergence and accommodation are very strongly associated, convergence relaxation exercises, as described in the preceding pages, will prove of great assistance in unlocking this association and making the latent exophoria and hyperopia manifest.

Base-in prisms are not to be prescribed for any manifest exophoria, but must be given to correct any latent exophoria that is revealed as the addition of plus lenses, in correcting the latent hyperopia, makes this latent exophoria manifest.

In myopia, insert at once the full recovery value of base-in prisms as found in the distance abduction test. Then proceed

to determine the true refractive error by using the cross-cylinders and base-in prisms at the reading distance as just described in the directions for determining the latent hyperopia.

No matter what the manifest myopia at 6 meters may be, that manifest myopia may be reduced, by prism wearing and Kratometer treatments, by the amount of plus added in this near point convergence-accommodation relaxation test.

For example, if we find a manifest myopia at 6 meters of, let us say, 8 D. Sph., if we find, in this convergence-relaxation test, that +2.00 D. is added as we pile up the base-in prism, then that myope's true refraction is −6.00 D. By prescribing base-in prisms and giving base-in exercises with the Kratometer, we can reduce the −8.00 D. Sph. to −6.00 D. Sph. with equally good, generally better, vision. Or, if we add 3.00 D. in the test, we reduce the −8.00 to −5.00.

If, at the beginning of this near test, the vertical lines are still blacker, use enough minus sphere to make all lines equally blurred. In low accommodative, or pseudo, myopia, say up to 1.50 or 2 diopters, often the full convergence relaxation can be developed at the first sitting, so that a permanent prescription of prism base-in can be given, leaving the eyes in their normal condition of emmetropia with exophoria. Convergence-relaxation exercises with the Kratometer can often be carried on so successfully that the association of accommodation and convergence is completely broken down. Then that first prescription of base-in prisms can be reduced, little by little, until the patient no longer needs glasses, but is emmetropic with normal vision, convergence and accommodation functioning efficiently and in co-ordination but without excessive association.

Or, if the true condition is a slight hyperopia, the relation of convergence to accommodation can be so modified by this treatment that the true plus correction can be worn.

CHECKS WITH THE CROSS-CYLINDERS

The cross-cylinder check, used binocularly over a correction found monocularly, shows the relationship of convergence to accommodation; reveals the relative status. When the horizontal lines are blacker, convergence is lagging; is not fully supporting accommodation. When the vertical lines are blacker, convergence must be inhibited.

In esophoria with latent hyperopia, if the esophoria persists after the manifest error has been corrected by the usual methods, turn at once to the Kratometer and Chart No. 2, using base-down and base-up prisms from the rotary disks to produce two images of the cross. If there is no exophoria at the usual reading distance, draw the card nearer to the patient, until an exophoria becomes manifest. Then proceed as on page 101, inserting sufficient base-in prism from the horizontal slides to correct this manifest exophoria, then adding plus spheres to both eyes to equalize the blur on both crosses. Then turn out the vertical prisms, so that the patient sees but one cross. Set the card at the reading distance, if the test was made nearer than that point, and reduce prism and sphere to equalize the appearance of the lines, always leaving in as much plus as possible and utilizing the prism to hold the convergence and associated accommodation in check.

Then set the card at the extreme outer end of the reading test rod, and again reduce. Then place Chart No. 1 at about 2 meters and once more reduce until the lines are equally blurred. Then retire the Chart to 3 meters and reduce, then to 4 meters, then to 5 and 6, and so on, to the extreme length of the room. This procedure will leave much more plus in place than the old system of "fogging" with reductions direct from an empirically chosen plus down to that lens accepted for clear vision of the distance test chart.

If the full reading correction for the non-presbyope, as determined by the cross-cylinder test, is not at once accepted

for distance accommodative orthophoria with clear vision, or if with the lenses accepted for clear vision some esophoria still persists, prescribe bifocals, regardless of age. These bifocals may well contain prism base-in elements in the reading segments. Give convergence relaxation exercises until the original reading correction is worn for distance with clear vision. It may happen that the final distance glasses, for a person who at first showed esophoria, will contain base-in prisms for constant wear. The cross-cylinder test can be depended on to show if these repressive prisms are necessary.

Sectional astigmatism is shown when either vertical or horizontal lines persist in appearing blacker regardless of the amount of sphere or prism added. Give Kratometer exercises in convergence relaxation until the full astigmatic correction as indicated by the ophthalmometer is accepted.

Jewelers, die-cutters and many other workers who must hold their work at eight or ten inches, will always need some base-in prism in their working glasses. For the repression of the accommodation effected by the strong plus needed for clear vision at so near a point will destroy the balance between accommodation and convergence. The exact amount of this prism is shown by the cross-cylinder test used with the Kratometer. First find the reading correction at 35 cm., then draw Chart No. 2 forward to the mark on the reading rod corresponding to the distance at which the subject must work. The vertical displacing prisms from the rotary disk are turned in, as previously described, and at once considerable exophoria will be found. Correct this with prisms from the horizontal slides so that the two crosses are directly above each other, insert the proper cross-cylinders, and the horizontal lines will come out black. Add sufficient plus sphere to make all lines equally blurred for both eyes. Turn the vertical prisms out, leaving the rotary disks at open. But one target is now seen. Adjust the prisms of the hori-

zontal slides until all both horizontal and vertical lines are equally blurred. Prescribe the base-in prisms thus found.

All hyperopes needing above +4.00 D. for distance vision will need a bifocal addition for near work. This is because the difference in lens effectivity for near and distance vision becomes noticeable at about +4.00 D. The amount of this addition can be figured out by a long mathematical computation, but this is unnecessary to the possessor of the Genothalmic Kratometer. Use Chart No. 2, with the proper cross-cylinders over the distance correction already found. The addition that equalizes horizontal and vertical lines is found in a moment.

The cross-cylinder test gleans the same information as to the habitual use and tonicity of the intrinsic muscles of accommodation as the dynamic phoria test gives as to the habitual use and tonicity of the extrinsic muscles of convergence.

In the phoria test, we make it impossible for the central nervous system to set both maculae simultaneously beneath the two images. Therefore, the sense of fusion being withdrawn, the attention must alternate between the two images. Consequently, the extrinsic muscles assume, not "the position of rest," but that degree of flexion indicative of their habitual reception of innervational and tonicity impulses. With the cross-cylinder test, we focus, simultaneously, an image anterior to and an image posterior to the tips of the cones of the retina. This introduces the novel sensation of simultaneous demand for both positive and negative accommodation, removing the visual sensory stimulus whose reflex is the adjustment of focus. Then the various fibers and subdivisions of the ciliary muscles are freed to assume the degree of flexion representing their normal tone. This is disclosed by the appearance of the lines when viewed through the cross-cylinders, the correcting lenses being in place.

Because of the involvement of all involuntary muscles in all normal or abnormal muscular reflexes in the various vital organs of the body, through the intricate intermeshings of the sympathetic nervous system, the ciliary muscles and the muscles of the iris are affected by abnormal activities in the internal organs. The size of the pupil has long been used in diagnosing certain involuntary system nervous imbalances. The use of the cross-cylinder, when its disclosures are appreciated, becomes of assistance to the refractionist in apprehending causes of distress which elude him under ordinary methods.

In the cross-cylinder test at 6 meters, when the health is good and involuntary muscle tone normal, the apparent emmetrope will see the vertical lines of the target (Chart No. 1) blacker than the horizontal lines. It will take about −0.25 D. Sph. to equalize the lines. Much more than this will be found in cases of hyperacidity of the stomach and in certain other imbalances. This minus, however, is not to be prescribed. In cases of manifest hyperopia, it will be found that the needed plus lenses are about 0.25 D. Sph. too strong, when the health is good, using the cross-cylinder test. But this 0.25 is not to be deducted from the correction.

In the distance test, when the binocular cross-cylinder test shows the vertical lines blacker, after the correct plus lenses that equalize the lines in the monocular tests have been found, it indicates that the patient is one of those who relax convergence-accommodation somewhat when one eye is occluded. Some people do, some do not. If they do, they accept more plus monocularly than they do binocularly. Such monocular corrections as are overcorrections in binocular vision cannot be worn with comfort. Either the plus must be reduced or base-prisms supplied to make horizontal and vertical lines alike.

In the reading point cross-cylinder test, the emmetrope or corrected hyperope of non-presbyopic age should never find

the vertical lines blacker. If the vertical lines are blacker, digestive troubles are invariably found, which will explain the visual discomfort.

Among healthy presbyopes, the proper reading correction is found when the addition is supplied that makes horizontal and vertical lines equally blurred. In middle aged people, we frequently find that the correction that makes horizontal and vertical lines equal is not strong enough for clear vision. Then we justly suspect digestive and intestinal disorders, usually there is a history of constipation. In this class, we frequently find that the lines are brown, blue or red in color instead of appearing black or gray. These colors indicate toxemias.

Among non-presbyopes, the cross-cylinder test shows the same proportion of convergence-accommodation "lag" at different ages as is found in the comparison of the distance and near (so-called "static" and "dynamic") skiascopic measurements. This should be remembered in checking the near work requirements. The horizontal lines are blacker, the amounts of plus that equalize the lines at different ages being about as follows: 35 to 40, 0.00 D.; 25 to 35, 0.25 D.; 18 to 25, 0.50 D.; 14 to 18, 0.75 D.; 10 to 14, 1.00 D.; 8 to 10, 1.25 or 1.50 D.; 6 to 8, 1.50 to 2.00 D.; 4 to 6, 2.00 to 2.50 D. There is some latitute to be allowed in this table for different individuals, but any very great variation has a distinct diagnostic meaning. Very much less, indicates latent hyperopia and there will be some difficulty in forcing such relaxation as will permit the full needed correction to be worn with clear vision. Very much more, when the pupils are rather large, is a sure indication of arrested development of the convergence-accommodation function. Give Kratometer exercises with base-out prisms. (Page 80.)

In both distance and near tests, when studying the proportions of latent hyperopia to latent exophoria, first equalize the lines by such plus or minus lenses as may be needed.

The cross-cylinder test, used binocularly with the Kratometer, is the only accurate way we have at present of determining the amount of the relative convergence, either "positive" or "negative."

In determining the amount of latent hyperopia, often the lines appear blue or red, to young people, when about half or two thirds of the latent hyperopia has been made manifest and corrected. These color aberrations disappear when the full latent is disclosed, the lines resume their black tones.

In certain nervous imbalances, frequently in elderly people, it is impossible to make both horizontal and vertical lines appear equally black before the cross-cylinders are inserted. In such event, it is useless to attempt the cross-cylinder tests.

In myopia, after reducing the minus to a minimum, as described in another section (page 134), if with the cross-cylinders in the near test, the vertical lines are blacker, use more base-in prism for reading, supplied as cemented segments. The amount of prism needed is that amount, added from the prism slides of the Kratometer, that will equalize vertical and horizontal lines. The horizontal lines should be blacker for the myope in the near test, with his distance correction on, according to the table on page 110. If the lines are equal at the reading distance, he is over corrected at the six meter distance.

In studying the relations of convergence and accommodation, when the horizontal lines are blacker, neutralize with plus spheres, then remove the spheres and, using the prism slides of the Kratometer, learn the amount of base-out prism that will equalize the lines. When the vertical lines are blacker, equalize the lines with minus sphere, then remove the sphere and neutralize the myopic tension, in part if not completely, with the Kratometer and base-in prisms.

The binocular cross-cylinder test, when used with the Kratometer, is the most delicately precise, the most informative, of any of the subjective tests at our command.

Cross-cylinder test lenses for use in the front lens cells of the Genothalmic Kratometer will be furnished at $8.50 for the full set of four pairs enclosed in a convenient case. In ordering, specify diameter, whether 1½ inches or 1¼ inches.

RELATIVE CONVERGENCE

Relative convergence is the individual's ability to change the amount of convergence in use without affecting the accommodation; that is, his facility in holding the image in focus while he converges more than usual or relaxes his convergence.

The amplitude of relative convergence is the sum of the positive relative convergence and the negative relative convergence. The positive relative convergence is measured by the amount of base-out prism that can be used without throwing the image out of focus. The negative relative convergence is measured by the amount of base-in prism that can be used without changing the focus of the image.

It is customary to say that the positive relative convergence is measured by putting on base-out prism until printed matter is blurred; that, in the same way, relative negative convergence is measured by adding base-in prism until the image is blurred. But this is not sufficiently accurate. For few persons can tell definitely just when the image begins to blur, hence, the accommodation is affected without the refractionist's knowledge, he credits a larger relative convergence than is the fact.

When the image becomes blurred, using base-out prisms, if the accommodation has been affected minus lenses will clear the image. Using base-in prisms, when the image blurs plus lenses will clear it if the accommodation has been relaxed. But many persons tell of a blur that is not cleared when these plus or minus lenses are supplied. Hence, such a method of testing is valueless.

The binocular cross-cylinders will measure accurately the relative convergence. For, starting in with both horizontal

and vertical lines slightly and equally blurred, the least change in accommodation is indicated by one set of lines becoming black while the other set remains blurred.

To measure the positive relative convergence, set the correction of the manifest error, as found by subjective tests, in the rear lens cells of the Kratometer. Make sure that both horizontal and vertical lines appear equally black. For the distant test, use Chart No. 1. For the near point test, use Chart No. 2. Put the cross-cylinders that slightly blur the targets in the front lens cells. Use the horizontal prism slides, bases-out, equal amounts over both eyes. So long as both sets of lines appear the same, we are measuring the relative positive convergence. The instant the vertical lines become blacker, we have reached the limit of the relative convergence possibility, convergence and accommodation are working together. This is not the field of "fusional convergence," as has been wrongly taught in the past, but is a field of associated convergence and accommodation. From this point on we may measure the ability of convergence to carry accommodation to a point beyond our usual habit. Minus spheres will equalize the appearance of the lines. The proportion of accommodation to convergence is learned by comparing the strength of the minus spheres with the amount of base-out prism used after the positive relative convergence point has been passed.

To measure the negative relative convergence, reverse the horizontal prism slides to bases-in. Use equal amounts of prism over both eyes. The instant that accommodation commences to relax, the horizontal lines come out blacker. We have now reached the limit of negative relative convergence and entered the convergence-accommodation field in which lies the latent hyperopia. Plus spheres will equalize the lines. This is not the field of "fusional divergence" as has been erroneously taught. The proportions of plus spheres used to the base-out prisms supplied after the limit of relative conver-

gence is passed shows the relation of convergence to accommodation.

There is a great variation among individuals as to the amount, or proportion, of positive relative convergence. Some who are comfortable have a high amount, others have a very low amount. The same is true of persons who are uncomfortable. At present, we are unable to determine whether the positive relative convergence should be high or not. In cases of arrested development of the convergence-accommodation function, positive relative convergence is always low.

But the negative relative convergence at the reading distance is of immense value in diagnosis. For whenever this is low, we find the patient is suffering from a lack of sufficient plus for near work. In comfortable cases, we find a negative relative convergence of from 15 △ to 20 △ at the reading distance. And when we find this amount in uncomfortable cases, the source of the trouble is not uncorrected hyperopia.

The proper amount of negative relative convergence to insure comfortable vision at the reading distance is represented by the meter angle of convergence at that distance. For example, supposing the patient's accustomed reading distance is at 16 inches. At that distance he uses 2½ meter angles of convergence. If his interpupillary distance is 60 mm., or 6 cm., he uses 6 x 2½ = 15 △ of convergence. His negative relative convergence must be 15 △. If it is less than this, he needs more plus sphere. Disclose the latent hyperopia by the methods described on pages 101-105 and supply the needed correction.

DIFFERENTIAL DIAGNOSIS AND TREATMENT

THE DYNAMIC DISTANCE PHORIA TEST

THE dynamic accommodative phoria test at distance must be one of the first steps in a well ordered refractive examination, for this is the guide to all subsequent procedure and is the key to a binocularly balanced correction. The findings of

this test show the convergence-accommodative habit of the individual with the tonicity of the convergence muscles.

Hence, the test must call forth the act of accommodation. For this reason, Chart No. 1 should be so mounted that it can be moved to different distances from the patient. If the vision is so poor that the chart cannot be seen, move the chart within the range of vision. If one eye is decidedly poorer than the other, but is a functioning eye, favor this eye by bringing the chart near enough to call this eye into action. (Page 24.)

Since we seek information as to the visual habits of the patient, this first test is to be made without glasses, or, if the patient is already wearing glasses, it is to be made with the old correction in the rear cells of the Kratometer. (Pages 23-24.)

Comparison of the distance and near phoria tests will give information of considerable value, as is discussed in the following pages.

As a routine, use displacing vertical prisms, base-down over the left eye and base-up over the right eye. (Pages 23-24.) Use as little prism as possible, but make sure that the two crosses are definitely separated, that is, that they do not merge into each other. There is less confusion if they are not thrown too far apart.

For distance, 3 △ base-down over the left eye; for near, 3 △ base-down over the left eye, 3 △ base-up over the right; these will generally give the proper separation.

But with left hyperphoria, these amounts may not give diplopia. Use the 5 △ prisms. If more than this is needed, try the prisms in reversed position, base-up over left and base-down over right. If this is done, remember that the positions of the crosses are reversed from those used in the text. (Page 24.) This is the first warning of a possible hyperphoria and inequality in vertical ductions.

The fixing, or dominant eye, will hold one of the images on its macula, and refer the position of the other from this fixa-

tion point. If the lower image belongs to the right eye, and the right eye is the fixing eye, the upper image is off the macula of the left eye. It is then easier to the patient to think of the upper image as being to the right or left of the lower. But if the left eye is the fixing eye, it will hold its image on its macula while the right eye's image is in the indirect field. Such a person will always speak of the lower image being to the right or left of the upper image. The refractionist must always be able to conform his mental attitude to that of the patient, to think in the patient's terms.

If one cross seems to waver, so that the patient cannot tell exactly where it is, this indicates an uncertainty and unreliability of nervous innervation. At once, we may expect to find poor ductions and poor motility. In these cases, try to find out the tendency of the wavering, is it toward an esophoria or toward an exophoria?

Many times, an orthophoria is first indicated, which suddenly becomes an exophoria, then jumps back to orthophoria again, may remain there, or may switch back and forth. Suspect exhaustion from uncorrected hyperopia or general low tonicity from lack of exercise and improper diet.

NEAR PHORIA TEST

Use Chart No. 2. Set at 35 cm. Procedure (pages 28-29) is much the same as in the distance phoria test. Comparison of distance and near phorias is of value in analyzing the case.

It is normal to find 2△ or 3△ more exophoria at the reading distance than at 6 meters. More or less than that difference has a significance, demands investigation.

Orthophoria at distance indicates good health and a high degree of muscular tone. Apparent emmetropia with orthophoria at distance means a considerable amount of latent hyperopia. If a high exophoria is found at near, then we have sure indication that it is time that the hyperopia must be made manifest and corrected, for this exophoria shows ex-

haustion from the load of carrying the hyperopic compensation. Use the Kratometer with base-in prisms to relax the convergence-accommodation. (Page 101.)

Low exophoria at distance, 2△ or 3△, seems to be the ideal. It represents an ability on the part of the individual to relax when opportunity affords, while the orthophore and esophore, more particularly the latter, ever maintain a condition of stress, or effort, even when the necessity is partially or wholly withdrawn.

But phorias must be interpreted in the light of the conditions under which the test is made. For instance, the esophore of the morning is apt to be the exophore of the late afternoon, indicating the fatigue resultant from his efforts to maintain clear vision in spite of a high structural hyperopia. On the other hand, the exophore of the afternoon may have been an esophore or an orthophore in the morning. Again, temporary depressions, mental or physical, will modify the phoria finding. So a single phoria test, especially at distance, may not always be sufficient ground for establishing a diagnosis. Particularly, this is true of exophoria. Esophoria always means hypertonicity and an esophoria found is a thing to be combatted.

Comparison of near and distance phorias, made at the beginning of the examination, with the old glasses on, or with naked vision if no glasses are worn, is more informative than either distance or near phoria test alone.

Less exophoria at near than distance, or more esophoria at near than at distance, or esophoria at near with orthophoria, at distance, when the difference is within 5△ or 6 △, generally means latent hyperopia and a supreme willed effort to keep it latent. But to find 15△ to 20△ more esophoria at near than at distance, or that much less exophoria, may be considered as a sign of some serious disturbance in the central nervous system, sometimes has been found accompanying brain tumors.

Esophoria; orthophoria or low exophoria at distance with a

high exophoria at near almost invariably is a sign of latent hyperopia and exhaustion from taking care of it.

The same phoria at near as at distance indicates latent hyperopia. Apparently the only difference between these cases and those of high exophoria at near, mentioned in the immediately preceding paragraph, is that the one with the high exophoria is completely exhausted by his labor while the other indicates that the individual is still able to carry the load, has not shown fatigue. He with slightly less exophoria at near than at distance is plainly over-driving himself. In all three, the Kratometer is to be used to relax the convergence-accommodation, make the hyperopia manifest and correctible.

If a myope wearing minus lenses without base-in prism shows less exophoria at near than at distance, or more esophoria at near than at distance, or esophoria at near with orthophoria or exophoria at distance, we may justly suspect that the minus correction is far too strong.

Considerable exophoria at both distance and near in elderly people indicates low general body tonicity from lack of exercise. It is proper to give Kratometer treatments with base-out prisms for the building of tonicity in the convergence muscles (page 73), but general exercise in the open air and balanced diet should also be insisted on if the Kratometer exercises are to be permanently beneficial. High exophoria at distance and near in growing youth indicates thyroid dysfunction. Refer to a neurologist. (Page 126.)

Hyperphoria is the same at distance and near when it is a true hyperphoria. If different in amount at different distances, it is a spurious hyperphoria. In that case, there are two possible causes, latent hyperopia and toxemia. Before decision is made, the latent hyperopia must be determined with the Kratometer. (Page 101.)

ESOPHORIA AT DISTANCE

Compare chart reading with amount of prism, base-out, required to vertically align the two images. (Pages 25-26.)

Take distance abduction, which will tell the patient's ability to care for the esophoria. (Pages 32-33.)

Find the recovery point (pages 32-33). From this is estimated the amount of base-in prism to be prescribed for combatting the esophoria. (Page 34.)

As previously noted (page 34), some base-in prism should be given to every esophore for constant wear. This is the quickest way to break down the hyper-tonicity of the in-turning muscles.

To the latent hyperope, give one-third of the recovery value found in the distance abduction test. To the esophore without latent hyperopia, give one-half of the recovery amount. To the myope with esophoria, give the full recovery amount. Divide equally between the two eyes in all cases. These amounts can be worn by these respective types without annoyance or distortions. (Page 34.)

Esophoria with latent hyperopia is distinguished by small pupils, for pupillary contraction is an associate of the convergence-accommodation function.

Esophoria in young women with dilated pupils indicates a psychopathic condition. Prescribe base-in prisms as above, give base-in exercises, refer to a neurologist. Avoid plus lenses, as a rule. Seldom do low degrees of corneal astigmatism need correction with cylindrical lenses, for the cornea generally loses its distortion when the stress occasioning it is removed. Abduction at the reading distance is generally low. Usually the near abduction is less with +1.00 D. spheres. (Page 37.) Then this is proof that plus lenses will prove an annoyance, even if by skiascopy plus seems to be shown. When near abduction is very low, give O. U. 2 △ prism base-in as an addition for reading, cemented segments.

If the pupils are small and the preliminary abduction test has shown an improvement with +1.00 D. spheres in the Kratometer (page 37), turn at once to the problem of near correction, without wasting effort on the distance tests.

Work out a tentative correction with the dynamic skiascopic and subjective methods. Note that in severe cases of esophoria, the shadow movement is often "against," although the needed correction is plus. With this tentative correction in the rear cells of the Kratometer, proceed to develop, or unlock, the full correction with the cross-cylinder methods. (Pages 101-104.)

Correct the corneal astigmia with plus cylinders before attempting to determine the static spherical defect. (Pages 91-93; 133, 134.)

After finding the full amount of latent hyperopia and determining what amount of plus ought to be worn (see page 127), place that amount of plus in the rear cells of the Kratometer. The prism slides are left with that amount of base-in prism in place that was needed to bring out the plus. Set some printed matter in the card holder, inquire of the patient if he can read it clearly. If not, adjust the prisms until he can. Now reduce the prisms slowly, 1 △ at a time taken from each eye, inquiring if the print remains clear. It may be possible to reduce the prisms to zero, leaving the patient able to read clearly with the plus spheres that are in the lens cells. If not, increase the prisms once more, up to 8△ or 10△ over each eye. Then reduce slowly to 4△ or 3△ over each, then increase again, then reduce, and so on, alternately increasing and reducing, breaking down the association of convergence and accommodation. It will take but four or five minutes of this exercise to so break into these associations that reading is clear and comfortable with the plus lenses that we desire to give. (See page 127.)

Leaving the plus spheres, with any cylinders that may be needed, in the rear lens cells of the Kratometer, insert the base-in prisms, using the prism slides, that have been decided on for use in the distance correction. Check this reading correction once more with the cross-cylinders, binocularly.

If it should happen that the vertical lines show up the blacker, add enough base-in prism, equal amounts over each eye, to equalize the lines. The first pair of glasses given to the patient will generally be bifocals, with the segments carrying the additional amount of base-in prism that has been needed to equalize the lines. However, it will always be found that these cases needing this additional bifocal prism have a poor near abduction.

For example, supposing we find the latent hyperopia is 4.00 D. Sph., that 3.00 D. of this needs correction. Let us assume that 1.00 △ base-in prism is the amount to be prescribed for distance wear. Say that though the patient can read clearly with the 3.00 D. spheres, yet the cross-cylinder test shows that 2.00 △ base-in prisms over each eye, in addition to the 1.00 △ of the distance correction, are needed to equalize the lines. Then the reading segments will carry 2.00 △ prism, base-in, over each eye. This is a temporary correction only and need be worn for only a week or so.

The next step is, with the distance prism in place, to reduce the spheres sufficiently to give clear distance vision. And the reduction must be made to give the same vision as the patient has enjoyed in the past. If he had 20/xx vision at the beginning of the examination, reduce the plus spheres to give him clear 20/xx vision. If he had 20/xv vision, give him glasses that will give him that same 20/xv vision, clearly, without the shadow of blur.

Give the patient bifocals, regardless of age. Take care of his near work requirements so he shall not suffer from the strain he has borne in the past. Give him clear distant vision so he shall be contented. Depend on the inhibitory effect of the base-in prisms to break down the convergence-accommodative stress, on the inhibitory effect of the plus spheres at the near work to make him grow willing to accept the relief he needs, on daily base-in prism exercises with the Kratometer to more speedily break the convergence effort that

carries accommodation to the compensation of the latent hyperopia.

Never give base-out prisms to an esophore. They make his troubles worse by still further building up the tonicity of the converging muscles, by still further decreasing the tonicity of the external recti. Such prisms bring temporary relief only, the eventual result is increase of the esophoria.

Give daily Kratometer exercises in convergence relaxation. (Pages 69-73.) As abduction increases, add more prism to the distance correction and more plus will also be accepted. The second prescription will carry more base-in prism and more plus for the distance with a lowered addition, but always keep the near point correction up to its full required strength.

After the full plus has been accepted for distant vision, the prism portion of the correction can be slowly reduced. The ultimate aim of this treatment is to make the full hyperopic manifest and correctible, so that the patient can wear the full plus correction with ease.

Pathological symptoms, probably due to eye strain, often found in esophoria with latent hyperopia are indigestion, intestinal pain (often with symptoms resembling those of appendicitis), chronic constipation, low blood pressure, heart palpitation, nervous exhaustion, hysteria. These troubles resist medical treatment until the latent hyperopia is corrected. Sometimes, in cases of low blood pressure, the pressure goes up while base-in prisms are worn, goes down when the prisms are taken away, goes up again when the prisms are worn. No explanation of this phenomenon can be made at present.

Induction must not be taken in any form of esophoria cases. Induction is always low, because of the hyper-tonicity of the converging muscles, the hypo-tonicity of the external recti. Induction will be good, will automatically increase, under the influence of base-in exercises, base-in prism wearing, the full correction of the latent hyperopia, because of the balanced tonicity resulting from this treatment. Never give

base-out exercises, for these only handicap efforts in getting on the full plus correction.

Left hyperphoria in right handed persons, right hyperphoria in left handed persons, is a frequent accompaniment of esophoria. Pay no attention to this hyperphoria for it will disappear when balanced innervation is restored to the functional control of the horizontal muscles.

The accommodative esophore is invariably of the strong-willed, dominating type, energetic and masterful. He is impatient of imperfection, has rejected for years the blurred vision of manifest hyperopia, has driven himself to the point of clear vision. No type of imbalance is so difficult to eradicate as this. The patience and resourcefulness of the refractionist will be tried to the utmost in overcoming the control of convergence over accommodation and rendering the latent error correctible. The Kratometer brings us the powerful tool we have long needed for the mastery of this difficult problem.

ORTHOPHORIA

Correction of any manifest hyperopia may or may not give comfort. A finding of orthophoria at either distance or near is no proof of freedom from eyestrain. Orthophoria at both near and distance always means latent hyperopia and excessive effort at near work.

Occlusion of one eye may, in some cases, relax some of the convergence and permit monocular correction of at least part of the error. In other persons no convergence relaxation will follow monocular occlusion.

If plus lenses fitted monocularly should binocularly alter a previously existent orthophoria to an exophoria, either the plus must be reduced or base-in prisms prescribed, temporarily, to the amount of this created exophoria. This is sometimes evidence of considerable latent error. Disclose this in full (pages 101-105) and treat the case by the same methods as outlined under the treatment of esophoria.

If there is no considerable latent error, and the patient complains of discomfort at close work, particularly if the patient is a young person, we may suspect arrested development of the convergence-accommodation function. One of the symptoms of this is rather large pupils and the finding by skiascopy of more plus than the patient accepts for clear vision. (Page 122.) Another symptom is the apparent need of weak plus spheres for close work. Do not give these but give base-out exercises with the Kratometer for the development of the convergence-accommodation function. (Page 80.)

With manifest emmetropia and orthophoria at distance, if there is complaint of fatigue at close work, the case is one of latent hyperopia.

Accommodative orthophoria at distance in presbyopes where the addition of the needed presbyopic correction increases the exophoria at near. This is evidence of an uncorrected latent hyperopia. This must be made manifest and corrected by the same methods as are employed in esophoria.

In myopia with orthophoria, minus lenses must not be given so strong that the orthophoria is lost and esophoria created, for progressive myopia will develop rapidly.

EXOPHORIA

The various types and causes of exophoria have been mentioned in previous pages. (Pages 28, 29, 53, 54, 115, 116, 117.) Bear in mind that exophoria is a symptom, it is not the cause of the discomfort but is a sign pointing to the cause, and other symptoms are to be noted together with the apparent exophoria.

In cases of low exophoria at distance, 2 △ to 4 △, perhaps a bit more in some cases, the chief thing to guard against is the creation of more exophoria by plus lenses accepted in the monocular tests. For most of these cases relax a bit of the convergence-accommodation action incited in the binocular sensations. So they show more manifest hyperopia monocu-

larly than binocularly. There are two types of these cases. One, when the pupils are of normal size, denotes some latent hyperopia which should be corrected. The other, with large pupils, generally proves to be a case of arrested development of the convergence-accommodation function. Careful discrimination is necessary, for the first type calls for base-in treatment while the latter demands base-out treatment. To confuse the two, to make an error in diagnosis, leads to disaster, loss of the patient's confidence.

In exophoria from exhaustion because of the need of plus lenses, the exophoria is less after correction of the hyperopic error. (Page 29.)

Where there is considerable manifest astigmatism, manifest hyperopia, manifest exophoria, the exophoria decreases when the proper plus lenses that give sharp vision are prescribed. In these cases, the final decision as to the correction must be the subjective test, for it is the stimulus of a sharp image that is needed to create a satisfactory motor response and development of tonicity. (Pages 27, 54.)

Accurate subjective testing, such as is needed in these cases, is impossible with the brightly illuminated test charts in general use. The eye is not sensitive to fine details under too bright illumination and it is not sensitive to slight changes in lens power when the test objects are brightly illuminated. Further, the eyes with the defects we are now discussing have no sense of fine discrimination, having never received a perfectly sharp image. Subjective testing for such eyes needs regulated illumination. (Page 27.)

The Genothalmic Visual Test Cabinet is the only apparatus provided with a means of regulating illumination. Lacking such a necessary piece of equipment, the refractionist is handicapped in giving proper care to this particular type of exophoria.

After finding the best approximate correction by the usual objective and subjective methods, reduce the illumination

until most of the letters become obscured. Then change sphere and cylinder until some of these letters are again seen. Such a correction will care for the exophoria.

Base-in prisms are not to be given in cases of exophoria because of the exophoria. When the exophoria is due to exhaustion from carrying a latent hyperopia, base-in prisms are used as in esophoria, to hold the convergence-accommodation in check so that plus lenses can be worn. The same amount of prism, based on the abduction tests, is used as in esophoria. (Page 116.)

To very elderly persons, 70 years of age or more, it is proper to give some base-in prism on the reading glasses. These people are tired, effortless, with low tonicity, as is shown by the high exophoria at near. If base-in prisms help, give them. But be sure that vision is thereby made brighter. Do not attempt base-out exercises. But to persons younger than this, do not give base-in prisms. If a high exophoria shows at near, make sure that the cause is not latent hyperopia. If not, give base-out prism exercises with the Kratometer to develop tonicity. (Page 73.)

Never give base-out exercises in cases of exophoria merely because there is an exophoria. First make sure of the cause. It is so often latent hyperopia, even in persons of 60 years or more, that base-out exercises, while giving apparent temporary relief, fail to afford that comfort the patient rightfully expects.

Beware of attempting to treat, by prescription of glasses or exercises, the high exophoria often found in rapidly growing boys, which is an indication of delayed absorption of the thymus gland and imbalance of thyroid and pituitary. (Page 118.) Refer these cases to a competent neurologist. His treatment will remove the cause, remove the exophoria that is merely a symptom.

In myopia with exophoria, minus lenses must not be given

that will decrease the amount of the exophoria, for such lenses will prove very uncomfortable.

Exophoria is often caused by toxic infection, as from decayed teeth, diseased tonsils and sinuses, etc. The same toxemia that causes a high blood pressure causes exophoria. Do not expect Kratometer treatments to prove beneficial in such cases. (Page 81.)

PROPORTION OF LATENT HYPEROPIA TO CORRECT

Seldom is it necessary or advisable to correct the full amount of latent hyperopia found. Sometimes most of it should be corrected, sometimes it is advisable to leave half or more uncorrected. This fact has always been recognized and there have always been disputes as to the proportion needing correction, with no means of so analyzing the case that satisfactory determination was possible.

By studying the proportion of negative relative convergence, we get a hint. We have already pointed out that the person with a negative relative convergence equal to his meter angle of convergence at his habitual reading distance is comfortable regardless of the amount of latent hyperopia. (Page 114.)

In the cases that need plus spheres, we find a low relative convergence, and frequently the larger part of the latent hyperopia is disclosed by base-in prism before the amount of prism equal to the ideal of negative relative convergence is reached. That amount of plus sphere that gives this ideal amount of negative relative convergence will prove a satisfactory correction.

Often, the amount of plus sphere obtained at this ideal point on the first test is the proper correction. Sometimes, however, we find that after wearing such spheres for a short time more plus is needed. Then this is not a wholly satisfactory method of determining the proportion of the latent hyperopia that is to be corrected.

In studying the proportion of latent exophoria to latent hyperopia, we find that in different parts of the field the proportions of plus sphere to base-in prism differ. We also note that to any given amount of prism there is in the beginning of the test a low amount of sphere, then a higher amount, then a lesser amount.

Citation of a typical case will illustrate this. We find that it is satisfactory to compare the plus sphere representing the latent hyperopia with each 4△ of base-in prism used.

In a given case, we find the negative relative convergence is 8△. That is, using the cross-cylinder test, horizontal and vertical lines appearing equal to the patient, we can insert 8△ of base-in prism before the horizontal lines begin to come out blacker than the verticals. Then we put in 4△ more base-in prism, the horizontal lines are blacker, +0.50 D. Sph., O. U., equalizes them. Then with 4△ more of base-in prism we get an additional +1.00 D. Sph., O.U. We now have 16△ of prism (8△ over each eye), with +1.50 D. Sph. We then add 4△ more of base-in prism, getting out another +1.00 D. Sph., total, 20△ of prism to +2.50 D. Sph. With the next 4△ of prism we get another +0.50 D. Sph., with 4△ more we get another 0.25 D. Sph., then adding more base-in prism we get diplopia. We, therefore, have found a total of +3.25 D. of latent hyperopia. Now note that after we reached 20△ of prism with +2.50 D. Sph., the proportion of sphere to each 4△ of prism decreased. That is, between 16△ and 20△, for 4△ of prism we got 1.00 D. of sphere. But in the next 4△ of prism, from 20△ to 24△, we got only 0.50 D. Sph.

If we correct the hyperopia found up to the point where the proportion of sphere to each 4△ of prism commences to decrease, we shall take care of the patient's need. In this case, then, we shall give +2.50 D. of the total +3.25 D. found.

The proportions will be found to vary in every individual. But, in practical experience, we find that if we care for the

proportion of the latent hyperopia as determined by this method, that we shall be successful in making our patient comfortable. We shall also find that not only is it extremely difficult to get on a larger proportion of the plus than this, but the patient will not be entirely comfortable if we attempt to force him to wear more than this proportion.

The method of relaxing the convergence-accommodation so that these corrections are worn with clear vision at distance has already been described. (Pages 101-105.)

CHECKING THE SPHERE WITH THE OPHTHALMOMETER

If the primary meridians of the two corneas are the same, generally the true refractive spherical error of the two eyes is the same. Skiascopy and subjective tests may both show that unequal spheres are accepted. Then these may not be safely believed. Further investigation is compulsory.

For example, say the primary meridian of the right eye shows a curve of 42 D., the secondary curve 43 D. The left eye shows the same. We then expect that the spheres and cylinders in both eyes shall be the same.

Suppose the primary meridian in the right eye reads 42 D., the secondary meridian reads 43 D. While in the left eye, the primary meridian is given as 42 D., with the secondary meridian's curve 44 D. We then expect that the left eye will accept a stronger cylinder than the right eye needs, but we expect the spheres to be the same.

On the other hand, if the primary meridians are of different curvature while a skiascopy and subjective tests show the same sphere is accepted in both eyes, we may doubt the accuracy of these findings.

Suppose the primary meridian of the right eye has a curvature of 43 D., with the secondary curve 44 D. The left eye, primary 44 D., secondary 45 D. We expect the cylinders to be the same, but the right eye should carry a stronger sphere.

If skiascopy or subjective test, or both, show equal spheres, then usually those results are wrong.

Whenever our suspicions are thus aroused, we should immediately use the methods described under "Finding the Latent Hyperopia" (page 101). With base-down prism over one eye, base-up over the other, cross-cylinders in place, the preliminary correction in the rear lens cells of the Kratometer, using Chart No. 2, proceed to find the latent hyperopia of each eye. Seldom will it occur that the ophthalmometer readings, as above described, have proved a false guide. For almost invariably we find that when the primary meridians of the two eyes are alike, the required spheres for the two eyes are alike. Or if the primary meridians, as shown by the ophthalmometer are unlike, the spheres will be unlike, the stronger sphere needed on the eye with the lower curve.

This gives a new and additional value to both Ophthalmometer and Kratometer.

ARRESTED DEVELOPMENT OF THE CONVERGENCE-ACCOMMODATION FUNCTION

The signs are: Poor vision; large pupils, or larger than normally expected at the age of the patient; much plus is found in skiascopy; there is a large difference between the static and dynamic skiascopic findings, more than is expected at the age of the patient (page 110); vision is not brought to 20/xx by the static skiascopic findings; no lenses are found that will give 20/xx vision; the dynamic skiascopic findings do not greatly improve near vision, aside from enlarging the images; part of the skiascopic findings may improve vision at either distance or near, but the whole finding is not accepted; the patient complains of difficulty in reading or other close work but makes no complaint, is not seemingly aware, of poor distant vision. We find this defect at all ages, but more commonly among children of from 8 to 15 years.

Children may be orthophoric or exophoric. Adults always show exophoria. There is never esophoria.

Vision will be greatly improved at once by base-out prisms. 1 △ to 3 △ over each eye are the usual requirements. If vision is about 20/XL, with static skiascopy about +2.00, O.U., with no improvement in vision using plus spheres of any strength, the use of approximately 2 △ base-out prism, O.U., will usually bring vision up to, or very nearly to, 20/XX. Or if vision is around 20/C, static skiascopy about +4.00, O.U., perhaps +2.00 may bring vision up to about 20/L, and 2 △ to 3 △ prisms, base-out, equal amounts over both eyes, will bring binocular vision up to 20/XXX, 20/XXV or 20/XX.

About 1 △, base-out, is prescribed for temporary wear. Base-out exercises with the Kratometer are to be given, about half an hour daily. In a couple of weeks monocular vision will be 20/XX. Give only that amount of plus sphere that definitely and provably improves vision. If plus spheres do not actually improve vision, give none, prescribe only base-out prism, 1 △, O. U., and give Kratometer exercises. (Page 180.)

It must be clearly understood that this treatment only applies when the retinae are free from toxins.

If one eye is more amblyopic than the other, as sometimes happens, it will generally be found that vision in that eye is habitually suspended. Give base-out treatments for amblyopia ex anopsia to that eye (page 105), and exercises for suspension (page 58).

These are cases that in the past have been called amblyopic, "prematurely presbyopic," the apparent amblyopia falsely attributed to lack of focus, to disease, as infected tonsils, congenital syphilis, etc. With the Kratometer at hand, the refractionist can quickly differentiate these cases from others that seem similar but are entirely distinct.

This type of case has been sadly misused in the past. Plus spheres have been crowded on, regardless of their effect on

vision, with the promise that after constant wear the vision would improve. But watching these cases, we find that even after many years of wearing such lenses, no improvement in either vision or comfort has been brought about. We have records of children and young people wearing such plus spheres from five to fifteen years with no gain in vision and with constant complaint of discomfort with or without their glasses. We have records of adults who have been thus mistreated with plus lenses from twenty to thirty years, years of misery and inefficient vision, particularly at near work. A few weeks of Kratometer treatment develops the lagging convergence-accommodation, comfort and peace are attained.

Note carefully that we do not advise the indiscriminate removal of plus spheres. When plus spheres actually improve vision, they must be worn, they may not safely be taken away, although it is very easy to bring vision up to normal with Kratometer treatments. But that would be creating a high latent hyperopia, the after effects on the digestive system, on the general nervous system, have been found disastrous. But when the function of convergence-accommodation has been arrested in its development, then it must be trained to function.

Similar symptoms are found in cases of in and up squint, hyper-esotropia. (Pages 146, 147.)

Some have attempted to explain the large amounts of plus found in these cases of undeveloped convergence-accommodation as "latent hyperopia." But this is not the fact. Latent hyperopia does not reveal itself so readily to skiascopy. After the treatment with base-out prisms, there is no doubt but that the hyperopia is made latent. Occasionally, but not often, when a child of twelve or fourteen is given this treatment, if four or five years later he or she finds employment, such as stenography or bookkeeping, where continued work at the near point is necessary, it may be advisable to disclose

this latent hyperopia and prescribe plus spheres with base-in prisms. When this is to be done, the near abduction test will show a low negative relative convergence. (Page 114.)

Adults with arrested development of convergence-accommodation, who attempt to do close work, often have considerable trouble with a shifting corneal astigmia, both amounts and axes constantly changing, frequent changes of lenses thus made necessary. In these cases, prescribe, O.U., 1 △ base-out, and give Kratometer exercises, base-out. The cylinder axes will then become stationary, usually at 90 degrees.

Positive relative convergence in these cases of arrested development is always low. (Page 113.) This is shown also by the low amount of base-out prism needed to incite the function so that clear vision and comfort are obtained.

Be careful to distinguish these cases from latent hyperopia. This type has large pupils, the latent hyperope has small pupils.

In cases of arrested development of convergence-accommodation in adults we frequently find the right handed person with a right hyperphoria, the left handed person with a left hyperphoria, just the reverse of what we find in cases of latent hyperopia. (Pages 123; 140.) In these cases, pay no attention to the manifest hyperphoria. It will disappear under the influence of the base-out treatments.

ASTIGMATISM

Sectional accommodation, which sometimes seems to neutralize corneal astigmia, at other times evidently produces an astigmatism when there is no corneal astigmia, is a theory that has neither been proved nor disproved. Whatever the cause that produces these vagaries, it will usually give way to base-in relaxation exercises with the Kratometer. (Page 91.)

But the astigmatism so often appearing in toxemia cases will not give way to exercises. The cause must be removed.

Astigmatism is to be corrected by the Javal rule, using plus cylinders, correcting the astigmatism with these cylinders before attempting to learn the spherical error. The theory of using minus cylinders, after fogging with plus spheres, or, in skiascopy, first neutralizing the meridian of highest plus error, has proved to have been highly speculative and entirely empirical.

The Javal rule, "Add 25% to the ophthalmometer finding and deduct −0.50," will be found to apply in the majority of cases when used as above. But very often, relaxation with Kratometer base-in exercises will be found of valuable assistance in getting subjective acceptance of these cylinders. The correction and relaxation exercises should be given at the reading distance. Not only is the reading correction of far more importance, in this industrial age, than the distance correction, but relaxation is far more quickly enforced.

A booklet, "The Genothalmic Ophthalmometer," containing the expected cylindrical correction according to the Javal rule, will be sent, gratis, on application.

In myopia, there is frequently a spurious and changeable corneal astigmatism, generally "with the rule," sometimes oblique, doubtless arising from the same tensions as produce the myopia, that will grow less, sometimes disappear, under the relaxing influence of base-in Kratometer exercises. (Pages 136; 139.)

MYOPIA

In more than half of the cases of myopia where the correcting minus lenses give 20/xx vision, the myopia can be considerably reduced by proper Kratometer treatments and the continued wearing of base-in prisms.

In all cases of myopia where correcting lenses give less than 20/xx vision, vision can be improved, often brought to 20/-xx with base-in prisms and Kratometer treatments. Often, less minus than the original prescription will, after this treat-

ment, give 20/xx or 20/xxv vision, when the original prescription gave but 20/lx or even poorer vision.

Sufficient number of cases have been treated to know for a certainty that in the majority of cases of progressive myopia the progress can be arrested by Kratometer methods.

First, find the true refractive condition, by the methods detailed in pages 101-105. Compare this with the manifest myopia as found by usual objective and subjective methods. The difference between these two findings will show the amount that the minus lenses can be reduced.

Take the distance abduction with the Kratometer. When the abduction is high, 10△ or more before diplopia occurs, the manifest myopia can be greatly reduced. When the abduction is low, not much of the minus can be taken off; but when the vision, with lenses, is less than 20/xx, it can be greatly improved.

Reduce the prisms, slowly, to the recovery point. This full recovery amount is the base-in prism part of the final prescription. For example, if the break is at 10△, recovery at 6△, prescribe 6△, 3△ base in on each eye. Do not be afraid to give high degree prisms, the higher the better so long as diplopia is avoided.

Then remove all minus spheres and cylinders. If there is corneal astigmatism, correct it with plus cylinders according to the Javal rule. There is now nothing in front of the eyes but base-in prisms, with plus cylinders if needed.

In low degrees of myopia, where −0.50 to −1.00 gave 20/xx vision, the base-in prisms alone will sometimes give the desired 20/xx.

If still short of 20/xx vision, as will be the case in medium and high manifest myopia, sometimes in low myopia, build up the minus correction by −0.25 D. steps. Take time about this, do not hurry. At each increment of −0.25 D. Sph., let the patient tell what he now sees on the distance test chart.

Where vision is less than 20/cc, so that none of the letters on the 6 meter chart are seen, set a test chart to whatever distance is needed to make some of the letters visible. Build up the correction to 20/xx if possible. If the 20/xx line cannot be attained, build up to the best possible vision. Where the manifest myopia is 10 D. or more, the first few additions of minus sphere may be in −1.00 or −0.50 D. steps. But do not proceed with this speed above 5.00 or 6.00 D. as a rule.

If 20/xx vision is obtained, do not prescribe those lenses, but reduce the minus somewhat. In adults it is generally inadvisable to reduce below 20/xxx. In children and young people doing much close work, it is better to reduce to 20/xl.

If there are cylindrical lenses, omit from the prescription such low powers as 0.25 to 0.75. On higher powers, deduct 0.50 cylinder in ordering the lenses. If proper treatment is given, the corneal error will decrease that much in two or three weeks.

All cases of myopia seem to have progressive stages, with intervals of non-progress. If the case happens to be in the progressive stage, the same amount of minus that gave 20/xx vision without prisms will be needed with prisms. However, we find that if we follow the regular procedure of prism prescription and reduce the minus sphere to 20/xl vision, the progress of the myopia is checked.

Where vision was less than 20/xx with the old correction, and could not be improved with changing the power of the minus spheres or cylinders, there is usually an immediate improvement of vision when the above methods are used. Generally the same amount of minus is required on the first prescription, but sometimes there is at once a remarkable improvement in vision with much less minus. All these cases improve vision under treatment with the Kratometer.

Before the prescribed lenses are adjusted, give fifteen to twenty minutes exercises with the Kratometer, using the

horizontal slides at bases-in. The prescription is then accepted without discomfort from diplopia or distortion because of the strong prisms.

Occasionally a myope is found who is annoyed, at first, by the full prescription, for distance wear, of the base-in prism representing the recovery point. But if daily base-in exercises are given with the Kratometer, this difficulty will soon pass away.

Give daily base-in exercises whenever possible. This will greatly speed the progress of the treatment. With the glasses that gave 20/XL vision, we soon find that vision improves daily. When vision is again 20/XX, if there is still some myopia that can be reduced, as was shown in the first test for "latent hyperopia," then repeat the above procedure. The distance abduction is now higher, the recovery point is higher, more base-in prism can be prescribed, less minus will be needed.

Sometimes the case is finished with but one or two changes of lenses, sometimes there must be five or six changes. Continue the case so long as you can reduce the manifest myopia. Do not be alarmed if high powers of prisms are accepted. They will do no harm, their effect will be beneficial to the patient, both in vision and health.

If the final prisms get as high as 6△ or 8△ over each eye, when the final reduction of minus is completed, the prisms may be reduced to 3△ or 4△, but should never be completely eliminated.

If, with the full amount of base-in prism and the lowest possible minus powers for the distance correction, an addition is needed for reading, give it, regardless of age. In those cases, it will generally be found that what was given for the first reading correction will become the distance correction in the second pair of lenses.

For ascertaining whether a plus addition will be gratefully accepted by a young myope, the subjective test is more re-

liable than dynamic skiascopy. For often in myopia we find the apparent paradox of arrested development of the convergence-accommodation function. Then dynamic skiascopy shows a strong "motion with" but the plus lenses that neutralize this motion are not accepted for reading. In normal myopia, the same differences between distant and near skiascopy, or "lag" of convergence-accommodation, are found as are tabulated on page 110. But the operator must remember that in this skiascopic test, the observer and his mirror are to be at the same distance from the examined eye in both distance and near tests. Using "dynamic" at a different distance than "static" will not give this comparative information.

If the near abduction is poor, give about 2 △ base-in prism over each eye as cemented segments for near work. If plus addition is needed, grind these prisms on the spherical addition. If no addition is needed, give plano prism segments. These need be worn, generally, only two or three weeks, when the abduction will have so much increased, at both near and distance, that more prism can be added to the distance correction, the bifocal prisms discontinued.

Prism prescription in myopia is based on the abduction test. Pay no attention to the exophoria.

Myopia with esophoria in adults is significant, usually, of digestive disturbances. Abduction is very low. Give base-in prisms for constant wear, additional prism segments if required, with weakest possible minus. Give daily base-in exercises with the Kratometer. Refer the patient to an alimentary specialist and order strictest attention to diet. Usually an alkaline diet is most helpful.

Myopia with esophoria in children who are wearing minus lenses generally indicates that the lenses are too strong. Give base-in prisms with Kratometer exercises and reduce the lens power.

In astigmatism with myopia, almost always the corneal

astigmia can be reduced by base-in prism wearing and Kratometer exercises. In prescribing corrections, where there is only 0.50 D. or 0.75 D. of cylinder, omit the cylinders from the prescription. In higher astigmatic errors, order the lenses with the cylinder powers about 0.50 D. weaker than those found during the test. For with proper attention, the corneal error will decrease that much. Ophthalmometer readings should be taken before and after each exercise period and a record of the changes carefully preserved.

On the low myopes, when all the minus has been eradicated, with perfect vision and comfort with plano prisms, the prisms may be reduced, finally eliminated. We find that if boys can be got safely past the age of 18, there is apparently no cause for further anxiety. But this does not apply to girls and they should be kept under observation for several years.

Daily exercises, while not imperative, will hasten the attainment of desired results.

There is a myopia of psychopathic origin, quite similar to the psycopathic esophoria of young women. It should be treated in the same manner, with base-in prisms. This myopia is seldom or more than 1.00 D., usually less. Often there is some corneal astigmia of from 1.00 to 1.50 D. Sometimes there is more corneal error in one eye than in the other. Seldom is it necessary that the astigmatism be corrected with cylinders, even when there is more to one eye than to the other. Generally the abduction is so low, both at distance and near, that base-in prism segments are needed for a time. Proper attention to these cases will bring eye comfort and will eliminate the manifest myopia and astigmatism.

Myopia is always to be regarded as a sympton of imbalance in the visceral organs, either in the digestive tracts, in the functions of metabolism, in the sexual organism, possibly in the endocrine glands.

In all cases of myopia, use base-in prisms, even when medical treatment is required. The Kratometer has proved itself

of so much value in handling myopic cases that its existence is justified, even if it had no other use.

HYPERPHORIA AND CYCLOPHORIA

In persons of advanced age, manifest hyperphoria is usually evidence of neuritis from focal infections. Neuritis (nerve toxemia) is characterized by inability to control muscles and functions that are normally associated. Such cases arise from infections from decaying teeth and tonsils, sinus troubles, auto-intoxication, high blood pressure, etc., and are to be given medical treatment only. Prism wearing and prism exercises are useless.

In healthy persons, tendencies to hyperphoria can be reduced by Kratometer treatment. (Pages 30; 44-47; 50; 55-57; 85-89.)

Many apparent hyperphorias are caused by imbalance between convergence and accommodation with frantic efforts on the part of the central nervous system to bring about clear and single vision. Therefore, always bring accommodation and convergence into equality of requirement before making final decision as to a manifest hyperphoria. Vertical ductions are always to be made with the full correction in place.

Of these induced hyperphorias there are two types. The latent hyperope, whether esophoric, orthophoric or exophoric, may show a left hyperphoria in the right handed person, a right hyperphoria in the left handed person. The adults with arrested development of the convergence-accommodation function reverse this, just as their difficulty is the reverse of the latent hyperopes, for the right handed person often shows a right hyperphoria, the left handed person may develop a left hyperphoria. (Pages 123; 133.)

To neither of these hyperphorias is any direct attention to be given. For the first, take away the need for over exertion of convergence accommodation with plus lenses, base-in prisms and Kratometer treatments, base-in. For the second, develop

the convergence-accommodation by base-out prisms and Kratometer training.

But when the right handed esophore has a right hyperphoria, we have another type. Here, we find that correction of the hyperphoria with prism "in position of rest," base-down over the right eye and base-up over the left eye, eliminates the esophoria. This seems to be the one type of esophoria that does not require base-in prisms.

Besides the hyperphorias above mentioned as associated with convergence-accommodation immaturity, we find three other types of right hyperphoria with exophoria in right handed people. The pupils are normal, convergence-accommodation is properly developed, there is no great amount of latent hyperopia, the exophoria is quite high, especially at near.

In the first type, base-down over the right eye reduces the exophoria. The reduction is best learned by using the F - L card, Chart No. 3. This type is rare.

In the second type, base-down on the right increases the exophoria, but base-up on the right decreases the exophoria. Prescribe "reversed prisms," base-up on right and base-down on the left, in equal amounts. Usually the use of 0.50△ on each eye is sufficient. Give exercises with vertical prisms in the same position and give exercises in general motility. (Pages 86; 82.) This is the most common type.

In the third type, any vertical prism in any position will increase the exophoria. Then weak base-in prisms, 1△ or 2△ over each eye, will eliminate the hyperphoria. Exercises with base-in prisms and especially exercises in general motility are highly beneficial. Ductions in all directions are generally poor.

The same three types of left hyperphoria of left handed persons with exophoria will be found. The same course of procedure is to be followed. Study the effects on the exophoria when vertical prisms are applied.

Left hyperphoria with habitual left head tilting in right handed persons, right hyperphoria with habitual right head tilting in left handed persons, is a very common occurrence. Give weak "reversed" prisms, base-up over left eye and base-down over the right eye, for left hyperphoria. The reverse for right hyperphoria. Give Kratometer training leading to the final elimination of the hyperphoria. The result of such treatment in that the head is held erect. Such persons are annoyed by dizziness when standing in elevated positions. This dizziness disappears when the vertical ductions are made equal, as they are by this procedure. This hyperphoria is an equilibration function, established to co-ordinate vestibular and visual sensations which are thrown out of co-ordination by the habit of head tilting.

Cyclophoria presents the same manifestations as does hyperphoria, and is often due to the same causes. Give Kratometer exercises in motility in all directions, including exercises with the prism slides at oblique angles. (Pages 82-89.)

The reader will note, from the above, that hyperphoria is to be interpreted in terms of dominant sidedness. It is not sufficient to say "left hyperphoria" or "right hyperphoria," we must also specify whether the patient is right or left handed.

Also note that there are more spurious hyperphorias and cyclophorias than true, that many are associated with convergence-accommodation imbalances and are to be cared for indirectly by bringing those functions to balance.

The careful observer will find quite a few hyperphorias of different type than those listed above. For example, there is right hyperphoria with left head tilting, left hyperphoria with right head tilting. In these there are involved cyclophorias. Much study must yet be given to hyperphorias before we may safely feel assured that we know exactly how to handle each type. We have here given what we believe is a valuable hint,

the matter of dominant sidedness. The author believes he is the first to have discovered the importance of this.

In the F - L test, sometimes one image is higher than the other. (Page 50.) It will be found, frequently, that as the prisms are adjusted, increased or decreased from the original 10△ base-out over each eye, that the two letters tend to move toward a common level. This, we believe, is evidence of a spurious hyperphoria due to toxins from local infection.

Sometimes, in the F - L test one of the letters appears torted. This is evidence of cyclophoria, and is, we think at present, a symptom of toxemia, especially in adults.

In using Chart No. 11, in testing the phorias and ductions in amblyopia ex anopsia (Pages 95-99), sometimes the image for the amblyopic eye is torted. This is doubtless evidence of an undeveloped functional binocular use of the extrinsic muscles, for the torsion disappears as we proceed with the development of acuity and binocular habit.

In all hyperphorias and cyclophorias the first problem is to find the cause. Rarely is the cause faulty congenital muscular structure, though there are such cases. If the cause is a toxemia from focal infection, proper medical treatment, in which regulation of diet is sometimes an essential factor, must be relied on. If the fault is an induced hyper-tonicity of one or more of the vertical or oblique muscles, inhibit it with prism, base over the hyper-tonic muscle. If the cause is an undeveloped function, train that function with proper Kratometer exercises. If the origin lies in an over exertion of the convergence-accommodation function, disclose the latent hyperopia and correct it.

In this text, we have spoken only of "hyperphoria," not of "hypophoria. Unless there is an actual tropia, it is very difficult to distinguish between right hyperphoria and left hypophoria, between left hyperphoria and right hypophoria. Generally the two are coincident, hyperphoria for one eye meaning an equal hypophoria for the other eye.

Cyclophoria is found by the use of Chart No. 4. (Pages 93-95.) With base-down prism over the left eye and base-up over the right, when diplopia occurs the upper image belongs to the left eye, the lower image to the right. If the right end of the upper line tilts up, it is left intorsion. If the left end of the upper line tilts up, it is left extorsion. If the right end of the lower line tilts downward, it is right intorsion. If the left end of the lower line tilts down, it is right extorsion.

With base-down prism over the right eye and base-up over the left, when diplopia occurs the upper line is the one seen by the right eye, the lower line is seen by the left eye. Then, if the upper line seems to tip upward on the right end, it is a case of extorsion of the right eye. If the upper line tips up on the left end, it is right intorsion. If the lower line slants downward at the right end, it is left extorsion. When the lower line slants downward at the left end, it is left intorsion.

Remember that the eye is torted in the opposite direction to the apparent slant of the line.

Sometimes both lines are slanted in opposite directions, meaning extorsion or intorsion of both eyes. Sometimes the torsion is equal, sometimes unequal. Sometimes both lines slant in the same direction, which would be a case of extorsion of one eye, intorsion of the other. Sometimes these slants are equal, sometimes unequal. The question as to which eye is extorted or which intorted is settled by finding which image belongs to each eye.

A slight extorsion is seldom of particular importance. An intorsion always means hyper-tonicity which must be broken down by exercises. (Pages 93-95.)

SUSPENSION AND SUPPRESSION

Suspension, intermittent visual attention and fixation, is a vestigial trace of the visual habits of those primordial animals who use alternating monocular vision. It is never found in esophoria, rarely in orthophoria, but is quite common in

exophoria. It is corrected quite readily by Kratometer treatments, which attract attention by the jumping image appearing suddenly on the field of indirect vision. The correction of suspension is merely the education of the visual centers in remaining attentive. (Pages 58-62.)

Suppression is nature's method of avoiding strain. It is very common in esophoria, very rare otherwise. It is to be cared for by the full correction of the hyperopic error, and Kratometer treatments with base-in prisms, creating the ability to maintain fusion of the two images without strain or fatigue. It is always wiser to use the Kratometer as a stereoscope with the special cards Nos. 3 to 10, for only in this way may the operator be sure that suppression is not occurring.

In suppression, cling closely to base-in prisms. In suspension, exercise with both base-in and base-out effects. In both troubles, motility and speed of adjustment are poor. After the habit of intermittency is fully and surely corrected, give the exercises in motility and speed of adjustment outlined in pages 82-85.

DIZZINESS

Dizziness, car-sickness, fatigue at the movies, eye-fatigue from motoring, are due to slow motility and slow adjustment. Where there is a high latent hyperopia, speed of adjustment is almost always slow, especially in esophoria. Full correction of the error will automatically release the tensions, give the flexibility and quickness of adjustment needed.

In esophoria without latent hyperopia, ductions are low, tensions great, flexibility of adjustment poor. Base-in exercises and exercises in motility will give the desired facility of adjustment.

In cases of slow adjustment, suppression often occurs. If suppression is continuous, there is no dizziness. When suppression is intermittent, the recurrence of two images, with

difficulty in bringing both maculae to the images because of the tensions retarding versions, then dizziness is a coincident. Exercises that speed up versions and increase ductions will alleviate the difficulties.

In suspension cases, adjustments are usually slow, especially in semi-intermittent suspension. Here the adjustments are slow because of the imperfectly developed binocular functions. Develop these functions, especially that of convergence-accommodation. The dizziness then disappears.

It is probable that the dizziness is due to imperfect timing of visual sensations with equilibration sensations. Because of slow ocular motility the visual sensations cannot keep pace with the information received from the vestibulum as to changes in bodily position. When the tensions impeding swift ocular rotations are removed, timing is perfect, there is no more dizziness. A few cases of sea sickness have been cured by Kratometer treatments, but it is too early to assume that all sea sickness can be thus cured. All cases of car sickness, however, that have presented themselves have been permanently relieved.

ESOTROPIA

There are two causes for esotropia. One is the constant endeavor to maintain vision in spite of a high structural hyperopia. The stress on the cerebellum of maintaining synergic check by the external recti against the heavy flow of tonicity to the converging muscles, innervated in the act of convergence-accommodation, exceeds its capacity. Release from the strain is sought by total abandonment of the check. The eye turns inward. The direction is either in and down or straight in.

The other cause is a spasm in the visceral organs, affecting the pregeminal routes of ocular control. The eye turns either in and up or straight in. This type is characterized by loss of control over pupillary reactions, over accommodation, over

the function of convergence-accommodation. The pupils are large, the skiascope shows high amounts of plus, great differences between static and dynamic skiascopy. The use of plus spheres does not improve vision. Symptoms are similar, as has been noted elsewhere, to those of arrested development of the convergence-accommodation function. (Page 132.)

In the first type, give bifocals and some base-in prism, 2△ to 3△ over each eye. Give all the plus that can be found by dynamic skiascopy for close work. Deduct enough to give clear distance vision. The ophthalmometer will show whether to expect the same spherical correction for both eyes. (Page 129.) Give exercises for amblyopia ex anopsia. (Page 95.)

For in and up squint. Give for constant wear 1△ or 2△ base-up over the turning eye. In these cases there is a tetanus of the superior oblique which is more quickly broken by the inhibition of base-up prisms than by any other method. Give Kratometer exercises, those for amblyopia ex anopsia, also base-up prism exercises over the deviating eye. Sometimes base-out wearing helps, sometimes it delays matters. The refractionist will have to try everything, but the base-up exercises will prove highly valuable in all cases. Sometimes strong base-in prism, 8△ to 15△ will almost instantly straighten the eye, sometimes this is useless. Strengthen the base-up prism for constant wear from time to time. Exercise daily for amblyopia ex anopsia, for when attention to the image is gained, that very attention will straighten the eye. Avoid plus lenses unless vision can be proved to be considerably improved by them. A few years ago this type was considered incurable by anything but operation. The advent of the Kratometer has made it possible to straighten these eyes, if the refractionist will use it properly and study the individual idiosyncrasies of the case.

Straight in squints are the most difficult, as a rule, since it is extremely hard to find whether the cause was a spasm or

the effort to see clearly. Sometimes a hint is obtained from inquiring at what age the squint appeared. For if it developed before the age of conscious visual effort, manifestly the origin must have been a spasm. Combinations of the methods described above and on page 85 will bring success. Always try the effect of a strong base-in prism. Sometimes the result is seemingly miraculous, as the eye straightens immediately. If such good luck does happen, give for constant wear, O.U. 4△ base-in. Develop vision in the amblyopic eye.

EXOTROPIA

Exotropia is always the result of suspended attention in the visual centers. Amblyopia ex anopsia is the result. The easiest to correct are the eyes that turn out and up, hyper-exotropia. The hardest are the eyes that turn out and down, hypo-exotropia.

In all the training is the same. Follow the directions given under "Amblyopia ex Anopsia." (Page 95.) Teach the brain to pay attention, the eye will lose its "amblyopia," will straighten.

Intermittent exotropia, when the eye turns out at times, is straight at other times, is due to intermittent attention. When the person is concentrating on the matter in hand, as in conversation or reading, the eye is straight. When attention is partially diverted, the eye turns out, generally out and up. These cases present no especial difficulty, now that we have the Kratometer. Use the Kratometer as a stereoscope, with cards 5, 6, 7, 8 and 9. Use other stereo views, marking the picture seen by the defective eye with a red seal, the other picture with a blue seal. Teach the patient to keep both red and blue spots constantly in mind. A very short time, perhaps fifteen to twenty treatments, with the Kratometer will cultivate the habit of continued attention, the eye remains straight. Be careful about the prescription of plus lenses, use the minimum. The same is to be observed in treatment of all cases of exotropia.

Use the Kratometer as a stereoscope with the proper cards in all cases of exotropia, as soon as vision in the turning eye is good enough to enable the patient to see the details of the picture.

DUCTIONS

It is erroneous to think of the ductions as measuring "pulling power" of muscles. It is mistake to think that we can segregate any one muscle by the means we have at command in our regular office equipment, for every rotation of the eyeballs is carried out by the associated activity of all the extrinsic muscles, each flexed or lengthened to meet the demands of the occasion. Measurements of the induction do not use the internal recti alone but call into associated activity all the inturning muscles, indicating the ability of the central nervous system to reciprocally innervate these and inhibit their antagonists.

Every muscular act, in every part of the body, is conditioned by a number of factors. The need of the present act is the source of the effort. The efficiency of this is conditioned by past habit, the associations of various muscles that have been developed by the routine activities of one's daily life; by the tonicity of the muscles, which is a matter of exercise and diet; by tensions due to disturbances in the vital organs, especially the digestive tracts and the sexual organs; by mental state, as worry, mental repressions or inhibitions, states of fear, anger, anxiety or mental calm; even the weather affects our ability to enforce muscular activity; by conditions of bodily fatigue or rest. All these, and many others, enter into the problem of muscular control. All these factors are reflected in the behavior of the ocular muscles when we make the duction and phoria tests.

The ductions represent the ability of the central nervous system to dissociate past habitual associations and form new associations at instant command. In this it is efficient or in-

efficient in proportion to the presence or absence of the various factors enumerated above.

A person with normally good ductions may be in such a state of mental perturbation at the time of the examination that the ductions are low. Or there may be a temporary affection of the digestive tracts creating such tensions that ductions are temporarily low. A single test of ductions is therefore not to be considered as an accurate index. It does, however, indicate tendencies to tension or freedom from such tendencies.

The esophore's ductions are low because of two factors: close association of convergence and accommodation and inability, or sub-conscious unwillingness, to dissociate; hypertonicity of the converging muscles and of the circular fibers of the ciliary with corresponding hypo-tonicity of their antagonists, the extrinsic muscles of divergence and the radial fibers of the ciliary.

Psycopathic cases, esophoric or myopic, show low ductions because of the mental state, which causes hyper-tonicity.

Vertical ductions are a test of the ability to dissociate the innate function of turning the two eyes together up and down, the only innate binocular function we possess.

In short, high ductions mean high dissociative ability, facility and flexibility in dissociating previous habit and forming new muscle associations. Low ductions mean tension, stress, inability to dissociate present muscle associations.

In hypo-tonicity, ductions may be low because of the condition of the cells of the muscle fibers or because of lowered conductivity of the nerve fibers. Either condition may be caused by fatigue from over work, either condition may be caused by toxemia from local infection.

When the amount of the induction grows less after repeated tests (page 40), the cause may be one or two of several conditions.

The entire bundle of nerve fibers may be so lowered in conductivity by reiterated use that only a minimal stimulation reaches the muscle. The nerve cells are not regenerated.

The cells of the nerve fibers may be in a refractory phase, unable to accept more innervational impulses until rested.

The muscle cells, being of low tone, may not have regenerated, hence, may be of low irritability.

Or, possibly, the muscle is in the incomplete tetanus state, has not rested and regenerated, cannot accept the stimuli of the "after load."

We may fairly say that this shows a susceptibility to fatigue. Doubtless the patient has forced contraction of the convergence muscles to such a degree that immediate rest and regeneration are impossible. The subsequent fatigue will be far greater than that produced by normal, unforced stimulation.

When this condition is found, all subsequent induction tests or base-out exercises should be conducted after the method described on page 79. The prism bars are advanced to 1 △ each, then returned to 0 △, then advanced by quick steps to 2 △ each, then back to 0 △, then advanced quickly to 3 △ each, returned to 0 △, and so on.

By doing this, the external recti are innervated, causing reciprocal withdrawal of innervation and tonicity from the inturning muscles. A tetanus period of the latter is thus avoided by the sharply defined inhibitory effects that are induced by the sharply defined innervational stimuli of the external recti.

These definite reciprocal innervations of the Kratomer are far superior to the necessarily irregular and indefinite innervational effects of rotary prisms. So far as loose prisms go, definite reciprocal innervations leading to full inhibition, full rest, full recuperation, are out of the question. Complete withdrawal of high base-out prism power does not cause

rhythmic inhibition of the flexed convergence muscles, does not avoid the tetanus phase.

To take ductions with prism before one eye only is physiologically incorrect. Nerve nuclei are arranged in pairs, work in couples, must be innervated and inhibited in pairs. Laboratory experiments have shown the confusion and stress excited in the central nervous system by attempts at ductions with prism over one eye only. Therefore, the Kratometer is built to provide innervational stimuli from both retinae at the same time and in equal amount.

The quickest way to create high ductions, either induction or abduction, when the low duction is due to hyper-tonicity, is by the wearing of base-in prisms for near work and the giving of base-in exercises at the reading distance with the Kratometer. When the low induction is due to hypo-tonicity, base-out exercises will develop the needed tonicity and increase the induction. The refractionist must carefully distinguish between these two opposing causes and methods of treatment.

The dictum that there should be a ratio of "6 to 1" between induction and abduction is found untenable. Physiologic functions are not to be reduced to mathematics.

The proportion of relative convergence is a vitally important part of the duction tests. In the abduction, both at distance and near, the negative relative convergence must be high. (Page 114.) It has not yet been determined whether the positive relative convergence should be high or low.

This is a question needing much study. The Kratometer with the cross-cylinders affords the best method of investigation that has yet appeared. (Pages 112-114.) We suggest this as a good subject for study by the student. What is needed is an accumulation of hundreds of records with full data as to the relations of convergence and accommodation before and after correction of refractive errors, full description of the

discomfort of which the patient complains, complete record of what is done to alleviate that discomfort, record of relative positive convergence at different times. Charts for such records have been prepared. (Pages 172-178.)

The recovery point is also of considerable importance. Probably this is an indication of the refractory phase of the muscles. A poor recovery might be considered as representing an unduly long continuation of the tetanus period. If so, then the recovery point becomes a highly important factor in diagnosis.

In the distance abduction test, the recovery point and the relative negative convergence point generally coincide. To this there is one marked exception, the migraine type mentioned on pages 33, 34.

The induction test must never be taken before the abduction test, nor before the latent hyperopia has been measured.

Prism prescriptions are to be based on the abduction tests, not on the manifest phorias.

SUPPLEMENTAL NOTES

Toxemia is of many origins and causes varied manifestations. Many exophorias, esophorias, hyperphorias, cyclophorias, myopias, even some manifest hyperopias, are of purely toxic origin. The student must learn to discriminate between functional imbalances and toxic imbalances. In many cases, the two causes are both present.

The F - L test will repay study. For this shows both toxic and functional imbalances. Only continued use of the test with careful observation of apparently minor symptoms will enable the refractionist to reach the point of effectual diagnosis.

Exophoria is not a synonym for convergence insufficiency. We have seen that there is an exophoria with latent hyperopia where there is a great sufficiency of convergence. Regard exophoria for what it is, an hypo-tonicity, either temporary

or permanent, of the convergence muscles. Exophoria is a physiological symptom, not a functional symptom.

Hypo-tonicity of voluntary or involuntary muscles is present in exophoria, in arrested development of the convergence-accommodation function, in manifest hyperopia, in the habit of suspension, in cyclophoria displaying extorsion, in hyperphoria with exophoria when there is no latent hyperopia, in exotropia.

Hyper-tonicity of voluntary or involuntary muscles is present in esophoria, latent hyperopia, myopia, suppression habit, the intorsion form of cyclophoria, in hyperphoria with esophoria or with latent hyperopia, in esotropia.

Esophoria may be accommodative, psychopathic or toxemic in origin. Accommodative esophoria is that type associated with latent hyperopia. Psychopathic esophoria is that form so frequently found in young women, without latent hyperopia and with dilated pupils. Toxic esophoria is often found associated with hyperacidity of the stomach, sometimes follows an attack of the mumps in adults, is found with such other disturbances of the viscera as tend to cause hypertonicities. All are successfully treated, so far as elimination of eyestrain and relief of headaches, with base-in prisms and Kratometer exercises.

Accommodative esophoria found in the morning frequently changes to exophoria in the afternoon, especially in middle aged persons who do much close work. The exophoria shows the exhaustion from the day's work. After a night of rest, opportunity for muscle and nerve regeneration, esophoria is the morning condition. We advise early morning and late afternoon tests of these cases.

The causes of exophoria may be toxic, psychic, systemic imbalances, malnutrition, nerve fiber (afferent or efferent) exhaustion, muscle exhaustion (with latent hyperopia), low afferent stimuli. "Afferent exophoria" has been described

(pages 27, 125) as that type in which, with a considerable corneal astigmic error, no possible effort can produce a clear image. Therefore, no great efforts are made. The result is hypo-tonicity of both convergence and ciliary muscles, manifest exophoria and manifest hyperopia. In arrested development of the convergence-accommodation we find the psychic type of exophoria. Another psychic exophoria is that noted in listless, indolent persons.

One of the difficulties encountered in the correction of manifest hyperopia with manifest exophoria is that a very slight overcorrection with plus lenses, while giving perfectly good vision in bright daylight, obstruct the vision of the wearer at twilight and night. The refractionist will avoid this error of overcorrection if he will use the Genothalmic Visual Test Cabinet with its reducible illumination. Turn the light low to simulate twilight conditions and give the correction that gives the clearest vision in dim lighting, testing binocularly rather than monocularly, keeping the plus at a minimum.

The present idea is that convergence-accommodation is an independent function, rather than an association, more or less loose, of two independent functions. Convergence-accommodation has been shown to be an attention reflex. Therefore, the development of convergence-accommodation depends on awakening the habit of attention, a point that has been stressed in preceding pages.

Stereoscopic vision is a psychic resultant of the mental comparison of two slightly dissimilar pictures (dissimilar because viewed from different points) seen, or visualized, in swift alternation. This is the latest concept. From studies in retinal rivalry, we would infer that portions of the two pictures are presented to the visual sensorium in alternation, rather than accepting the idea of total alternation.

Stereoscopic vision requires, is built on, concentrated at-

tention. An essential is swift mobility of all muscles, extrinsic and intrinsic, with harmonious co-ordination. When lacking, stereopsis can be cultivated with Kratometer exercises, thus developing attentive habit and free motility.

Stereoscopic vision is possible even if the two images are not equally clear, provided there is the habit of concentrated attention and free mobility that enables both maculae to swiftly place themselves beneath their respective images. Even though one eye is considerably amblyopic, stereoscopic vision becomes a characteristic of the patient's visual habit as soon as the Kratometer exercises create these two desiderata. The use of red pictures for the amblyopic eye with red glass over the good eye (pages 95-99) so stimulates the habit of attention in the cortical centers receiving sensations from the amblyopic eye that stereopsis is one of the earlier developments in the course of training.

Recently the suggestion has come from several sources that in treating amblyopia ex anopsia of one eye, either with or without squint, a red glass be given for several months continual wear over the good eye. The use of such a glass during exercise periods has been attended with such remarkably good results that the proposal sounds sensible. Several refractionists are experimenting along this line. We suggest that others take this up when occasion offers. It may be that this method will be found of great value in the treatment of squint.

This method of simultaneous development of vision and binocular functioning, using the stimulus of bright red for the amblyopic eye, reducing the stimulus to the better eye by filtering out the red from its image, originated with the writer, in 1924, while experimenting with the Kratometer in comparison with older methods of visual development.

EXAMINATION METHODS

The methods described in this book are entirely binocular.

If the refractionist will cultivate the habit of doing the larger part of his work with both of the patient's eyes uncovered, with fixation and all visual functions under binocular control, he will avoid the many pitfalls of monocular occlusion and monocular testing.

Much time will be saved, both for refractionist and patient, much fatigue will be spared the latter, if the near correction is made first. Most stresses are more apparent at the reading distance than at six meters, relaxation of functions is more readily enforced. Correction of astigmatism will be more accurate if the first work is done at the reading point. It is better to make these tests at the patient's individual accustomed reading distance than at an arbitrary distance chosen for use in all cases without regard to the patient's idiosyncrasies.

Modern life demands hours of near work. The near work need must be cared for. The method developed a century ago of fitting the manifest optical error at six meters is now archaic, does not meet present day requirements.

Regardless of whether or not the patient is presbyopic, bifocals should be given when needed. The purpose of giving bifocals to non-presbyopes is not to assist vision but to inhibit the tendency to over exertion in those individuals who are able to supply the needed energy to compensate their structural error but who thereby exhaust themselves.

The pair of eyes is a binocular instrument. Let us develop methods for studying the manner in which the central nervous system uses this binocular instrument. The two eyes are not, in the human organism, two separately functioning organs, they form an entity. Let refraction methods conform themselves to this physiological fact.

The Kratometer is, par excellence, a binocular instrument, especially adaptable to the study and solution of the problems of near work.

THE KRATOMETER IN SKIASCOPY

Skiascopy with the Kratometer is fraught with great possibilities. Both static and dynamic are easily performed. The operator stations himself at the end of the test card rod. Draw the test card holder back to the end of the rod. For the target in dynamic skiascopy, paste or clip a few letters, or one of the various skiascopic targets, in the center of the top edge of one of the charts and place yourself with the skiascope in line with this fixation target. By bringing the skiascopic mirror to a position immediately above and very close to this target, you can work very close to the line of the visual axis. Changing the mirror from one eye to the other during the dynamic test is unnecessary. The fixation may be held at the one point while the observer moves backward or forward. Or the target may be slid forward while the observer remains in the same position (the left hand pushes the card holder while the right is occupied with the skiascope), or the observer may follow the target as it is moved toward the patient.

In static skiascopy, the patient looks at the distant test chart while the observer moves to a position in front of the left eye or the right eye, whichever is being measured. His position is gauged by putting himself in line with the eye openings of the instrument.

The batteries are adjusted to the interpupillary distance of the patient. If desired, his old correction may be put in the rear lens cells. Necessary changes in lens power as the test proceeds are made by inserting trial case lenses in the front lens cells. Arrange the trial case so that it is convenient to the left hand, and the lens changes are readily made.

The rotary disks are set at 10△ base-in. The horizontal prism slides are set in their holders at 10△ base-out. There is now 0△ before each eye. Decrease the prism slides to produce

base-in effects and watch the movement of the skiascopic reflex as the base-in prisms are increased.

By this method, we may make objective checks of the subjective tests of negative relative convergence and of the latent hyperopia in its relation to the latent exophoria as described in previous pages. (Pages 101-105; 112-114; 127-129.)

When the shadow movement is "with," neutralize, as customary, with plus spheres. Then add base-in prism, 1 △ at a time over each eye. So long as there is no shadow movement, we are measuring the negative relative convergence. When the shadow moves "with," we have entered the convergence-accommodation field. Neutralize with plus spheres, add more prism. The shadow movement is again "with," add more plus. And so on until the total latent hyperopia is measured. Keep records of the proportion of sphere to prism as detailed on page 128.

Another method of studying the relations of convergence to accommodation is to use the skiascopic in objective check of the cross-cylinder check described on page 111. When the movement is "with," first neutralize with plus spheres, as is the custom, then remove the plus spheres and neutralize the shadow movement with base-out prisms. This is particularly valuable when studying cases of arrested development of the convergence-accommodation function.

When the shadow movement is "against," neutralize with minus spheres. Then remove the minus spheres and neutralize with base-in prisms. This is a most excellent method of studying the effect of base-in prisms in myopia.

When necessary, adjustments of the prisms in the rotary disks to increase or decrease the power of the prisms in use is easily made.

Skiascopy with the Kratometer is easier than skiascopy with rotary prisms because we are rid of the annoying reflections of the latter. It is more efficient, just as Kratometer prisms are more efficient than rotary prisms. With convergence-

accommodation under efficient control with the prisms in front of the eyes, there is no lost control while lenses are being changed. This prism control is steady. We know how unsteady and unsatisfactory is attempted control with plus spheres. Repression or innervation at will is possible by shifting prisms.

We repeat what has been said previously, that to get information concerning the convergence-accommodation function from skiascopy, the refractionist should make both tests from the same distance, deduct the same amount for working distance from both findings. Dynamic skiascopy has other uses when made at different distances which have been well covered by various writers. We are here pointing out one value to the comparison of distance and near findings which has been given little attention. (Pages 110, 130.)

The skiascopist who uses the Kratometer in following through the various suggestions we have made as to the study of the convergence-accommodation function will be delighted with the wealth of information he obtains.

THE FOUR STEPS OF TRAINING

In all training, whether it be learning to play the piano, learning to read, learning to write, learning to play golf or other game, learning to use the eye functions correctly, or learning to do anything, in all human activity, there are four steps, or stages, of the training.

1st: Building the pathways. That is, learning to send commands to the muscles over the nerve fiber pathways in such a way that the act is successfully consummated with a minimum of effort. When improper habits have been established, this first step includes the destruction of the old pathways from central system to muscle, their replacement by new and proper pathways.

2nd: The habit of concentrated attention. This is an out-

growth of the first step. Cultivation of continued attention, until it becomes a subconscious reflex, becomes an accustomed muscular reflex to the sensory stimulus.

3rd: Speed. When the reflex pathways have become fixed, cultivate speed of response. Then flexibility becomes possible, and not until then.

4th: Variety of exercises. This develops facility in making new adjustments in proper co-ordination. Specifically, in ocular exercises, here is where we undertake the exercises in "General Motility." (Page 82.)

Balanced tonicity, swift interchange or reciprocal innervations, follow surely, when these principles are followed.

THE THREE TYPES OF REQUIRED TRAINING

All cases will come under one of three headings, though there may be an occasional case with characteristics of two types.

One type consists of those cases where a function is not fully developed, as in arrested development of convergence-accommodation; some cases of suspension.

Another group is made up of cases of lowered tonicity, as cases of high exophoria due to lack of exercise; exotropia; occasional suspensions or suppressions.

The third group includes the hyper-tonicities, as in esophoria; myopia; latent hyperopia; some hyperphorias and cyclophorias.

We have tried, in the preceding pages, to differentiate between these, to indicate the kind of treatment most likely to succeed.

But the practitioner must remember that diagnosis and prognosis lie in discovering the cause. He must regard the symptom for what it is, a sign only. He must not treat the symptom, for then he is apt to select the improper method.

To give base-out exercises in a case of high exophoria at the

reading distance when that exophoria is a sign of fatigue because of an over worked convergence-accommodation can but lead to failure; equally disastrous will it prove to give base-in exercises in a case of high exophoria with arrested development of the convergence-accommodation function.

To develop a function, we cause the performance of the act thousands of times, and the performance must be correct if we establish the function as a subconscious reflex.

To create tonicity, we exercise the hypo-tonic muscles, but we must most scrupulously avoid fatigue or the production of even a temporary tetanus in the muscles whose innervation we are forcing.

To inhibit tonicity, we exercise the antagonist muscles. But in such cases the inhibition must be constant. Therefore, in addition to the daily exercises we prescribe prisms for constant wear with the bases over the muscles whose inhibition we seek.

EXERCISE PERIODS

DAILY exercises for short periods are far better than long periods spent once or twice a week. For we are training functions, educating the nervous system to proper habits. Home exercises are of little avail, save in very simple cases. The patient is not under guidance and can easily develop wrong habits in his home exercises.

Fifteen to twenty minutes daily are ample. Some individuals cannot stand that much at first. Study the patient, and conform your practice to his requirements.

The various cards are arranged in the chart holder in their logical order, so that no time is lost in changing from one to another. One or two minutes on each card, the whole series run through daily, will soon accomplish the desired results.

Many cases can be fully disposed of in two or three weeks. Stubborn and complicated cases may require as many months, perhaps a year.

To conserve the refractionist's time, make it possible for the busy practitioner to include this work in his crowded day, insist that each patient have a definite time at which to appear for his or her treatment, and that he or she must come exactly at the appointed hour, or lose the appointment. Also, make it clearly understood that every day's treatment must be paid for even if the patient does not come to take it. In this way, regularity is secured, and without regularity nothing can be accomplished.

POSSIBILITIES OF THE GENOTHALMIC KRATOMETER

THE Genothalmic Kratometer methods educate FUNCTIONS when these are but partially developed or have become impaired. The Kratometer exercises, as outlined in the preceding pages, go direct to the root of muscular innervation as it is directed in the central nervous system. Correct and prompt innervational habits; proper distribution of innervation and inhibitions; associated control over muscles that should be synergistically innervated; quickness in associations, dissociations and regrouping of muscular innervations so vital to efficient functioning of binocular vision; reduction of time loss in the synapse; all these are made possible if the Kratometer is used thoughtfully and intelligently.

No single piece of apparatus has yet appeared that will reveal so many of the idiosyncrasies of a poorly functioning pair of eyes. The refractionist is urged to cultivate a habit of keen observation, to listen with attentive mind to chance remarks of his patients, to study the abilities and disabilities of the pairs of eyes under treatment as revealed in the course of his work with the Kratometer. For often one of these chance remarks will lead to a series of observational studies that will enable him to penetrate the mysteries of that particular pair of eyes, guide him in the development of special educational exercises particularly applicable to that particu-

lar pair of eyes, thus assuring him of success, his patient of comfort, and enhancing his reputation in his community.

BOOKS FOR STUDY

THE studious refractionist will gain much from the study of modern physiologies, particularly of those sections in the text books describing the physiological action of muscles, the conduction of nervous impulses, the laws of nutrition. Many of the newer books on the anatomy and functions of the nervous system, also some of those treating of nervous diseases, contain much that applies to the refractionist's daily work. Such books will carry the student much farther in the understanding of his work than the extremely speculative writings that have been produced by the ophthalmologists, optometrists and optical physicists of the past two generations.

RECORDS

THE charts shown on the following pages are designed for Kratometer users. They show in pictured form the essential features of a case, are planned to require the minimum of writing. They show comparisons of such important items as the phorias at near and distance; break, recovery and relative convergence in both induction and abduction tests and exercises; proportions of latent hyperopia to the prism required for its disclosure; hyperphorias and vertical ductions; cyclophorias; etc.

The first two charts shown (pages 167, 168) are for recording the results of the examination. The next two charts (pages 173, 174) are for recording in graph form the results of exercises.

These charts are printed on paper or thin card, as the refractionist prefers, size 5 x 8 inches. They may be filed in standard cabinets of that size, or, if one prefers, may be folded, inserted in 4 x 6 envelopes, filed in standard 4 x 6 cabinets. The examination charts are printed on two sides of a

single sheet. Likewise with the exercise records. Prices per thousand will be quoted on request.

THE EXAMINATION RECORD

The obverse side of the examination card carries the usual information of the ordinary chart plus spaces for some of the diagnostic points mentioned in this text.

Since the size of the pupils is such an important item in interpretation of the phorias, it should always be noted whether they are about normal, considering the illumination of the room, or unusually large or small. The light reflexes, as is well known, are symptomatic points in the recognition of many pathological and psychopathic cases.

Always record the ophthalmometer readings in full. Note the expected astigmatism by the Javal rule. Note the increase or decrease since the last examination.

Under "Skiascopy" are provided spaces for the comparison of distant and near skiascopic findings when made with the observer at the same distance during the two tests. The "net" finding, after deducting the working distance is to be recorded. Also, there is a place for recording findings by whatever form of dynamic skiascopy the refractionist may use. A new item is introduced in the spaces for "Plus revealed by Base-in Prism" and "Plus covered by Base-out Prism." (Refer to pages 158-159.)

In the place for the subjective findings, always record the illumination used. This subjective finding here recorded is not the final prescription, but is recorded for comparison with the skiascopic findings.

The F - L test is recorded, together with the notation of any suspension or suppression found.

On the reverse side is an entirely new method of recording phorias, ductions, relations of convergence and accommodation. This illustrated method gives a picture of the essentials of the convergence-accommodation function, as found in

NAME Age Date

Headache Eye Complaint

Recent Sickness Indigestion — Constipation — Acidosis — Rheumatism

Blood Pressure—High—Low—Normal. Notes

Naked Vision Right —— Left ——

Visual Axes Apparently Squint

Versions

Lids

Conjunctiva

Fundi R

L

Opacities Lens Cornea Vitreous

Wearing for yrs.: Distance

Right S C Ax Pr B Vision R——

Left S C Ax Pr B L——

Wearing for yrs.: Reading

Right S C Ax Pr B

Left S C Ax Pr B

PUPILS

Large Normal Small

Direct Light Reflex

Right Left

Consensual Light Reflex

Right Left

Conv-Accom Reflex

Prompt — Slow — None

OPHTHALMOMETER

R { Pri Mrd / Sec Mrd

L { Pri Mrd / Sec Mrd

Plus Cyl. Javal Rule { R Ax / L Ax

Change since

R

L

SKIASCOPY

Distance (Net) at M Near (Net) at M

Right S. C Ax Right S. C Ax

Left S. C. Ax Left S. C. Ax

Dynamic at M { Right S C Ax / Left S C Ax

Plus revealed to skias. by Base-In Pr.: Sph Pr

Plus covered to skias. by Base-Out Pr.: Sph Pr

Subjective for best vision Illumination lumens

Right S. C Ax Vis

Left S. C Ax Vis

Subjective Reading

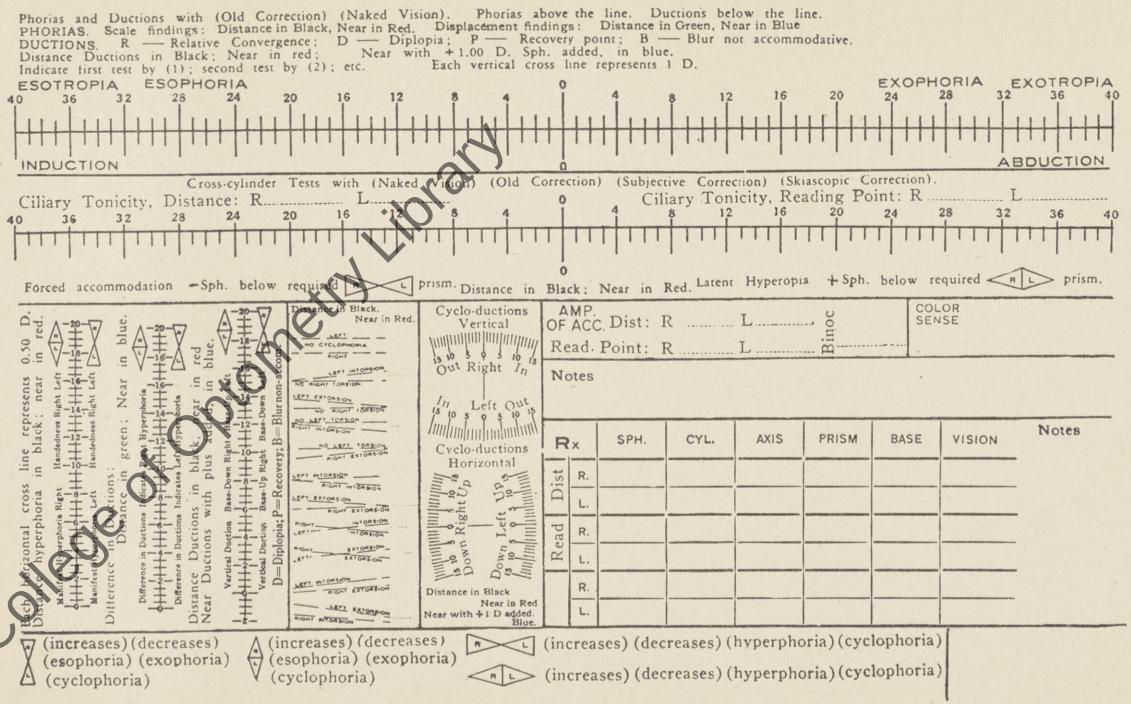
Add Right Left

F-L TEST: E with △ Bases-out (Normal 20△)

Abduction Suspension Rt Lt

Induction Suppression Rt Lt

Examination Record Card—Obverse



Examination Record Card—Reverse

these tests, which is far superior to the methods of writing out.

All distance records are made in black and green. All near records are in red and blue. As the distance and near findings appear side by side, recorded on a single scale, the comparison stands out in such way as to force the attention of the diagnostician.

Handy pencils, of the reservoir type, containing black, green, red and blue leads, can be purchased at stationery stores, or will be furnished by the publishers, at $1 each.

In the first chart on the page, the phorias and ductions, either with the old correction or without glasses, are recorded. Cross out the words "Old Correction" or "Naked Vision," as the case may be, leaving the words that indicate the conditions of the test.

Each vertical cross-bar of the scale represents 1.00 △. Exophoria and abduction tests, base-in records, are noted at the right of the figure 0. Esophoria and induction, bases-out records, are noted at the left of the figure 0. Phorias are recorded above the line, ductions below the line.

To indicate the phoria by the scale reading at distance, draw a black line above the vertical cross-bar at the proper point. To indicate the amount of prism needed to bring the two targets into vertical alignment, check with a green mark above the required prism power. Thus the two records stand side by side; where there is a difference, one's attention is called to the fact. When in taking the phoria by the scale, one of the images "wobbles" back and forth, showing some uncertainty as to amount, draw a wavering mark above the approximate amount, thus indicating the irregularity of tonicity.

In the same way, record the phoria by scale reading at the near point in red. The displacement prism required is checked in blue.

There we have a picture of near and distance phoria tests by the two methods that is far more compelling, is more quickly noted, than are written records of the four results entered in different spaces of a record card.

The four essentials of the duction tests, Relative Convergence, Diplopia, or breaking point, Recovery Point, Blur that is not accommodative, i.e., that is not cleared by plus or minus spheres, are indicated by the letters R (Relative Convergence), D (Diplopia), P (Recovery Point), B (Blur, non-accommodative) inserted below the line, opposite the proper prism power, bases-in on the right side, bases-out on the left side. Distance findings in black, near findings in red.

If more than one duction test is made, which seems an essential of the induction test, indicate the first finding by the numeral 1 after the letter D and after the letter R; the second test by the numeral 2; the third by 3; etc. Thus, D2 in black, below the 18 △ mark on the left side, means that in the second induction test at 6 meters diplopia occurred at 18 △. R2 in black below the 12 △ mark means that in the second induction test at 6 M., the patient recovered the single image at 12 △, bases-in. The same indications in red would mean that the test was made at the reading distance.

The near abduction test with +1 or D. Sph. added, so valuable in the information it gives, is recorded in blue, below the line, on the right hand side. Both diplopia and recovery points are to be recorded.

The second chart is for recording the results of the cross-cylinder tests.

Cross out the unused words, "Naked Vision," "Old Correction," "Subjective Findings," as the case may be, so that the condition under which the test is made is shown by the unmarked words.

Enter the power of the plus or minus sphere needed to equalize the lines, for right and left eye, both distance and reading, in the spaces provided after "Ciliary Tonicity."

If phoria tests are made with the cross-cylinders in place, or if the test is made with the experimental subjective findings, indicate these phoria findings above the line, after the manner described above.

Indicate Relative Convergence, Diplopia, Recovery, by the letters R, D and P, as above.

Below each 4△ of base-in prism, indicate by numerals and the +sign the amount of latent hyperopia uncovered by that amount of prism. Thus, +2 written beneath 16△ on the right side, means that with 16△ of base-in prism +2.00 D. Sph., O. U., is needed to equalize the lines of the target. Distance amounts are recorded in black, near amounts in red.

On the left side, indicate by numerals with the minus sign the amount of minus sphere needed to equalize the lines to each 4 △ of base-out prism. Thus, having started at 0△ with the lines appearing equal, if with 20△ base-out prism it takes −1.00 D. Sph., O. U., to equalize the lines, write −1 below the 20 on the left hand side. Distance findings in black, near in red.

Hyperphoria is recorded on the first vertical column at the left of the page. In all these vertical columns, each cross-bar represents 0.50△ of vertical prism. Record distance in black, near in red.

Cross out the word "Right" or "Left," as the case may be, so that the uncrossed word indicates the side of the manifest hyperphoria.

Handedness is also to be indicated by crossing out the word "Right" or "Left."

The difference between the two vertical ductions, base-down over right with base-up over left as compared with base-up over right with base-down over left, is recorded on

the second vertical column. Normally, in true hyperphoria, the difference between these two ductions should be twice the amount of the manifest hyperphoria. By recording both the manifest hyperphoria and the difference between these ductions, we obtain valuable data.

Sometimes the difference in ductions indicates a hyperphoria just opposite to that found in the phoria test. So always record whether right or left hyperphoria is indicated by the ductions by crossing out either "Right" or "Left."

Vertical ductions are recorded on the third column. Ductions with base-down over the right eye and base-up over the left are entered at the left side of the column. Ductions with base-up over the right and base-down over the left are posted at the right side.

Indicate by the letters D, P, B, respectively, the points of Diplopia, Recovery and Blur. This blur in the vertical tests may be accommodative or non-accommodative. To discover if it is accommodative, take the vertical ductions at near with the full plus as found in the latent hyperopia test and record the findings in blue. If the hyperphoria is caused by the stresses of latent hyperopia, this will be proved by the blue records showing better ductions than do the red records.

If more than one vertical duction test is made, record first, second, third, etc., findings by numerals 1, 2, 3, etc., after the letters D, P, B.

In the spaces provided, record the effect on manifest exophoria or esophoria of vertical prisms in different positions. Also, record the effect of base-out or base-in prisms on manifest hyperphoria and cyclophoria. When plus or minus spheres increase or decrease exophoria, esophoria, hyperphoria or cyclophoria, note this. This is recorded by crossing out the unwanted words.

Cyclophoria is indicated by marking opposite the proper drawing the condition found. These drawings represent the

various appearances of horizontal lines when using Chart No. 4 for the vertical ductions.

The degree of manifest cyclophoria is found by so turning the line that appears oblique that it appears horizontal. The number of degrees that the lines is turned is entered under "Deg." opposite the picture of the discovered condition.

An attachment for measuring cyclophoria is in preparation and will be ready soon.

With this attachment, the degree of cyclo-induction and cyclo-outduction can be measured. Places are here provided for recording both the horizontal and vertical duction tests.

Finally, enter the prescription ordered in the space under "Final Prescription."

EXERCISE RECORDS

For recording the results of a series of exercises, we advise the use of graph record charts. (Pages 173, 174.)

The obverse side of the card is used for recording the horizontal ductions and phorias on different dates.

Enter in the first column the prescription being used and record successive prescription changes. Always note the date on which the prescription is changed in the date column at the left.

In the graph, each vertical space is for the record on the date entered, so that successive results are recorded in vertical order, read downward.

Each horizontal space represents 2.00△. Mark distance findings in black, near findings in red. Indicate the manifest exophoria or esophoria by a dot or check mark. Post even powers, as 2△, 4△, 6△, in the spaces. Post odd powers 3△, 5△, etc., on the vertical lines.

Often, the amount of esophoria or exophoria is greater at the beginning of the exercise period, decreases as the result of exercises. It is well, in such cases, to make two records, the first, marked (1), indicating the phoria at the beginning of

the exercise, the second, marked (2), taken at the conclusion of the exercises. In the same way, the ductions should be indicated by (1) and (2), showing, respectively, the ductions at the beginning and the end of the exercise period. Thus one has a check of the amount gained each day and the reversion, if there is any, on the succeeding day. We thus learn if the improvements are transitory or permanent and how long it takes to turn a superficial improvement into a lasting one.

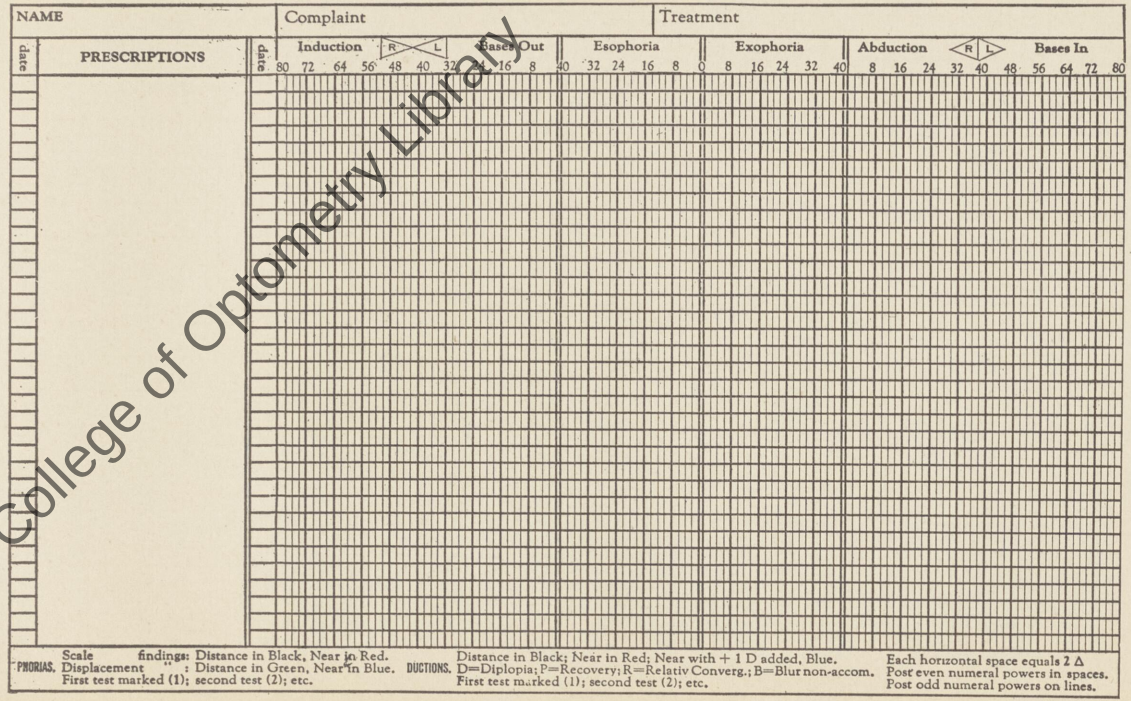
Post on both abduction and induction records the diplopia points (D), the recovery points (P), the relative convergence points (R), the non-accommodative blur points (B). Distance findings in black, near findings in red. (Sometimes there is no B point. Just what occasions this peculiar blur is unknown.)

After a few days of exercising, draw a black line connecting the black D's; another line connecting the black P's; another connecting the black R's; another connecting the black B's. Similarly, draw red lines, connecting the red D's; the red P's; the red R's; the red B's. Continue these lines down the page from day to day. Also draw lines connecting the daily records of the phorias. These lines are graph curves showing the changes brought about by the exercises.

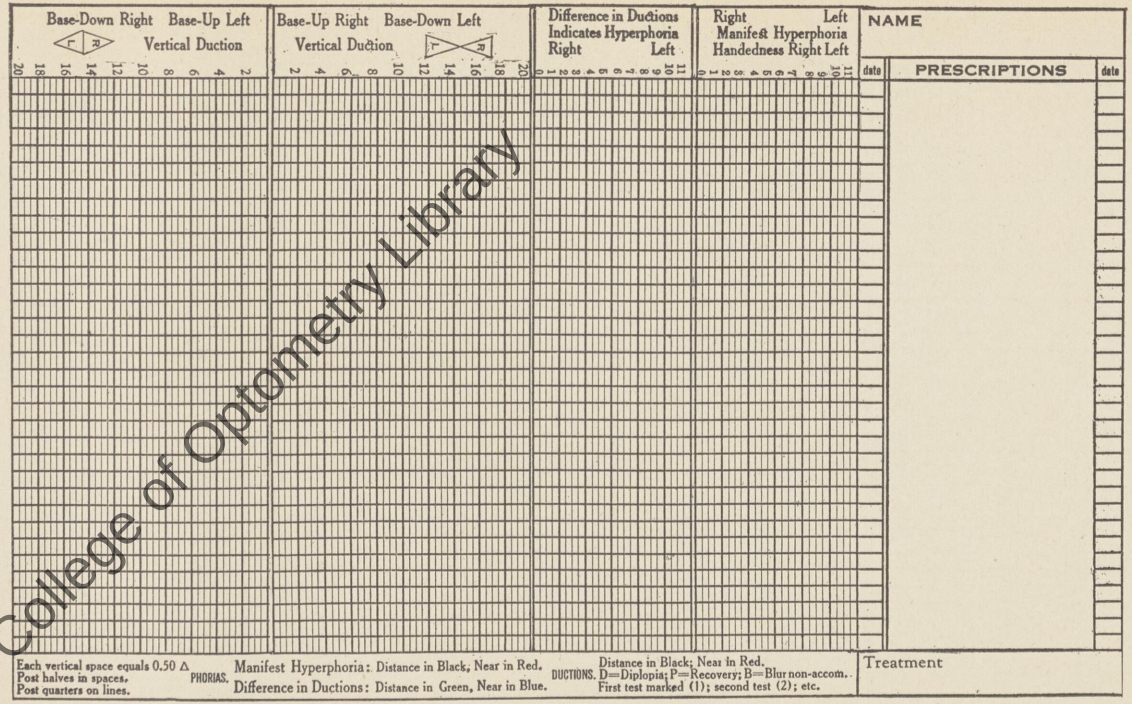
Thus, at a glance, the refractionist sees the progress, the work accomplished. Or, if there has been no progress, the fact stands out with startling clearness.

On the abduction side, the diplopia points, recovery points, relative convergence points, should increase. The graph lines should curve to the right in the descent of the page. They will not run parallel at the beginning of the treatments, but should run parallel after a time. In fact, when the three graphs run parallel and well over to the right, we may consider that the treatments are successful. A line curving to the left is a bad sign.

On the induction side, the graphs connecting diplopia points and the graphs connecting recovery points should



Exercise Record Chart—Obverse



Exerecise Record Chart—Reverse

curve to the left. A curve to the right indicates an error in diagnosis. Then base-in exercises should be substituted for base-out, if the latter have been given. A straight graph would give similar indications.

When base-in exercises are given, the induction should be checked occasionally, perhaps weekly. Both diplopia points and recovery points, when graphed, should curve to the left in the descent of the page. A graph thus made will show beneficial effects of base-in exercises in increasing the induction.

The graph of positive relative convergence will show different curves in different types of cases. One great value to be expected from this system of recording is that we may thus eventually learn something definite about tbe positive relative convergence.

The phoria graphs should curve toward the center of the page, toward orthophoria. If two records are made daily, before and after exercising, recorded as (1) and (2), graph each. Progress is indicated when the (1) graph merges with the (2) graph. In fact, this must happen if the results are to be permanent.

A further elaboration with inviting possibilities as to the gaining of deeper knowledge, would be the charting in green for distance, in blue for near, the amount of displacement prisms needed for vertical alignment of the two targets in the phoria tests, when this is different in amount from the scale reading.

Always write in, at the top, the kind of exercises given. Otherwise, the graph will have but little intrinsic value for study purposes.

On the reverse side of the card is the record of hyperphoria and the results of vertical exercises. The date records are entered horizontally, the phorias and ductions are recorded vertically. So the graph lines, when drawn, run horizontally, picture the departure from and approach to vertical orthophoria.

Each vertical space represents 0.50 △ of vertical prism power. Record half and full diopters, as 0.50△, 1.00△, 1.50△ 2.00△, etc., in the spaces, the quarter diopter intervals, as 0.75, 1.25, etc., on the horizontal lines. Use the letters as in other records, D for diplopia point, P for recovery point, B for blur. Distance in black, near in red.

Record changes of prescription with the dates of change entered in the right row of date squares. Enter the date of exercises in the left row of date squares. Describe the type of exercises given in the blank space at the bottom.

The graph charts are four in number. The upper one is for recording the amount of manifest hyperphoria shown in the vertical phoria tests. Indicate whether right or left by crossing out the unwanted word. Indicate handedness in the same manner. Indicate amount of manifest hyperphoria by dot or check mark, distance in black, near in red.

The second chart is for recording the difference between the two vertical tests, base-up over the right eye and base-down over the left as compared with base-down over the right eye and base-up over the left. Indicate by dot or check in green for distance, in blue for near.

The third section is for recording the ductions with base-up over the right eye and base-down over the left eye. Use letters and colors as in other records.

The fourth section is for recording the ductions with base-up over the left eye, base-down over the right eye. Use letters and colors as above.

After a few exercise periods, connect the various points with graph lines. In the first two charts, the graph line should curve downward, toward 0△. In the third chart, the curve should be upward in cases of right hyperphoria, increasing in amount; downward in cases of left hyperphoria, decreasing in amount. In the fourth chart, in cases of left hyperphoria the curve should be downward, increasing in amount; upward in cases of right hyperphoria, decreasing in amount.

The results of vertical exercising are so slow in showing progress that records need not be made daily. Once a week, sometimes once a month, suffices. Remember, that vertical prisms must often be given, for constant wear. Their effect is to be recorded on these charts, even when no specific exercises are given. Also, many times, horizontal exercises have an effect in reducing apparent hyperphorias and inequalities of ductions. So vertical tests are to be made at regular intervals, perhaps weekly, and here recorded during the progress of the horizontal exercises.

The graph system is the recognized scientific manner of recording the results of investigations. The graph shows so much at a glance and is so useful, so necessary to reliable recording and valid study, as distinguished from speculative study, that it should be adopted by refractionists, must be adopted if we would raise our systems to the level attained by investigators in other professional and industrial fields.

An accumulation of graphs showing the results of exercises will advance our knowledge and proficiency in this work, show us what may be expected in certain types of cases, teach us how to discriminate between different types, enable us to avoid wrong diagnosis.

We propose, after a number of Kratometer users have adopted this form of charting results, to establish a central clearing house, where students will study graphs sent in by refractionists, sort different types, gather statistics, chart composite graphs, publish the results, which publication will be placed in the hands of those who contribute their graphs to this central laboratory. Those who are interested in the development of such research work should address the writer of this text.

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